Off-flavors : the cause and (supposedly) how to get rid of them

Shamelessly plundered from:

http://www.kroc.org/Links/TroubleshootingGuide.htm

http://www.howtobrew.com/section4/chapter21-2.html

http://www.carolinabrewmasters.com/examstudy/Offflavors.htm

http://en.wikipedia.org/wiki/Main_Page

http://research.unc.edu/endeavors/win2002/beer.htm

http://blog.khymos.org/2007/02/16/lightstruck-flavor-in-beer/

http://www.homebrewzone.com/off-flavors.htm

ACETALDEHYDE

CHARACTERISTICS: Acetaldehyde is the flavor and aroma of green apples. It can also taste and smell acetic/cidery.

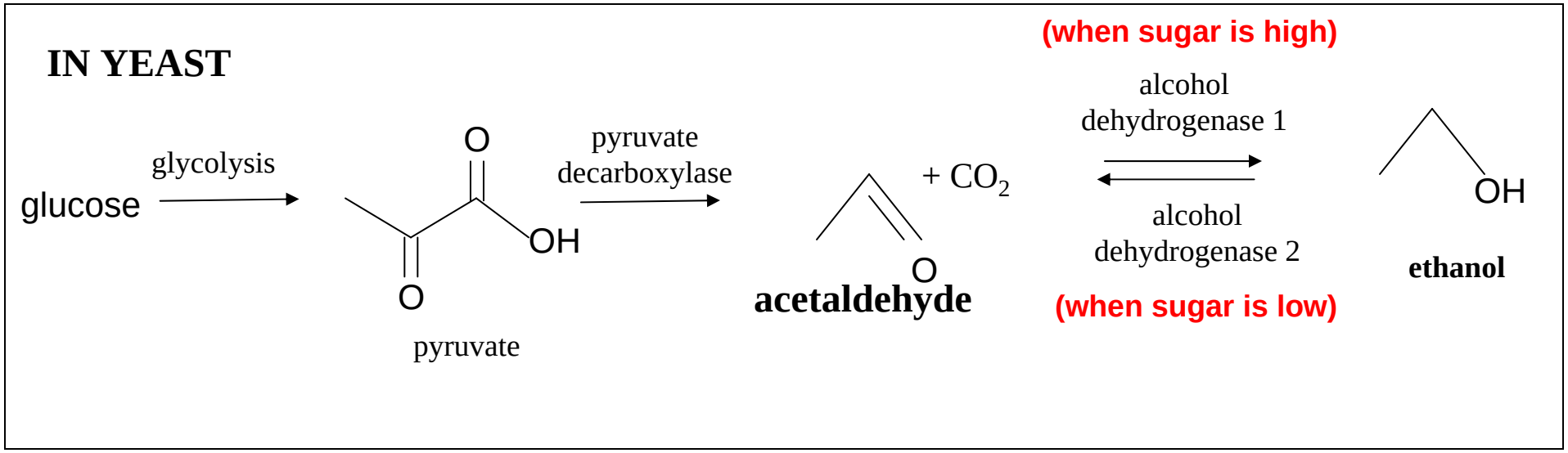
CAUSES: Yeast metabolism uses acetaldehyde as a step in the production of alcohol from glucose. This is a fresh, fruity flavor. The second cause is the oxidation of alcohol to acetic acid, whether by oxidation or by acetobacter (gram-negative).

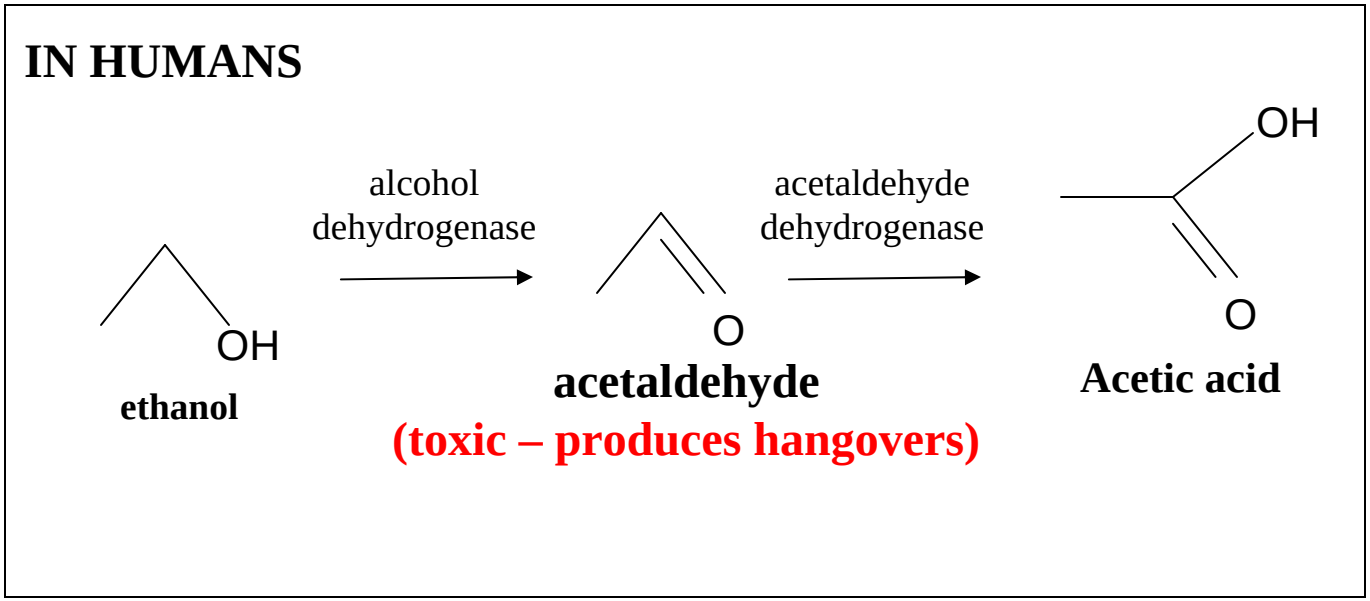
PROCESS: As a product of yeast metabolism, it can be caused by the strain itself or by premature termination of the yeast's fermentation such that the reaction from glucose to alcohol is stopped at the acetaldehyde stage. The other causes are oxidation and contamination by acetic acid bacteria. This will occur during splashing when racking quiet beer (non-kraeusened) and bottling.

REMOVAL: Use a good yeast strain that will attenuate the wort properly. Oxygenate the wort at yeast-pitching time. DO NOT splash or oxygenate the wort when racking or bottling. Long lagering periods will also reduce acetaldehyde.

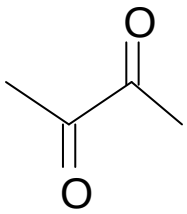
EXAMPLES: Budweiser deliberately manipulates their yeast and process to give 6-8 ppm acetaldehyde in the beer.

Metabolism of Alcohol in yeast and humans





DIACETYL



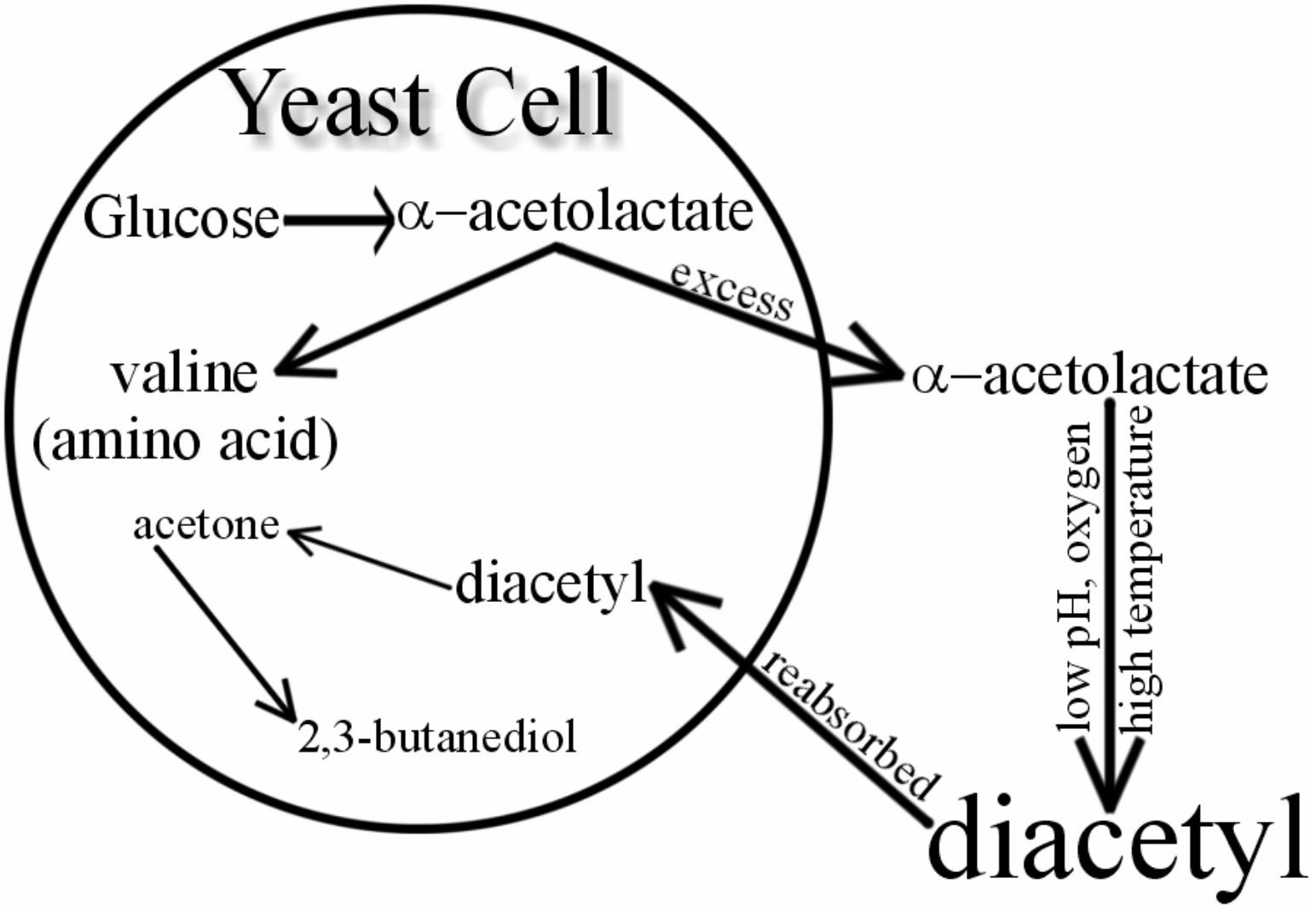
CHARACTERISTICS: A butterscotch aroma and taste, and a slickness on the palate. Not desired in excessive quantities. Presence recognized down to 0.05 ppm, but identified at 0.15 ppm.

CAUSES: A normal product of yeast during fermentation, it is re-absorbed during the course of a normal fermentation. Another cause are the bacteria Pediococcus cerevisiae and Lactobacillus strains if the mash held at low temperatures (below 131 degrees).

HIGH RATES FROM PROCESS: Underpitching of yeast; long periods of wort cooling (overnight); contamination from equipment; poor yeast strain; too-soon clearing (fining) of yeast (before it can reabsorb the diacetyl); too long an acid rest in mash; high adjunct ratio in wort; low fermentation temperature; premature lagering; **any process that stimulates yeast then immediately removes it from suspension**; use of contaminated sediment for re-pitching (bacteria coexists with yeast in the sediment).

REDUCTION: Sanitation, quick wort chilling combined with adequate yeast starter amount (8 ounces of slurry to 5 gallons), adequate time for primary ferment before lagering or fining/filtering, all-malt recipe, higher temperature primary fermentation, pure yeast culture, washing yeast sediment prior to repitching. Diacetyl rest – leaving beer on lees for 3 days after fermentation is complete. For lagers heat to ale temp for three days.
EXAMPLES: HIGH: contaminated homebrew; MODERATE: Sam Smith's Nut Brown Ale, Pete's Wicked Ale.

Production and re-absorbtion of diacetyl



http://beerme.com/diacetyl.php

OVERLY ALCOHOLIC

CHARACTERISTICS: Both an aroma and a mouth-feel. A hot, spicy flavor detected by the nose as a vinous aroma and by the tongue by a warming sensation in the middle of the tongue.

CHEMISTRY: The end product from the conversion of glucose into carbon dioxide and ethyl alcohol. Other, higher alcohols called fusel oils (eg, propanol, butanol, amyl alcohol) and contribute to vinous aromas and tastes.

CAUSES: A normal reaction desired in beer, alcohol content is a function of the amount of fermentable sugars in the wort, the fermentation temperature, and the yeast strain. **Fusel oil production will be a function of the yeast strain used and the fermentation temperature (higher temperatures give more fusel oils).**

PROCESS: Amount and types of fermentables in wort determine content; yeast strain and attenuation characteristics; fermentation temperature determines fusel oil characteristic.

REDUCTION: The amount of alcohol and fusel alcohols should be appropriate for the beer style. Control fusel oils by using colder fermentation temperatures.

EXAMPLES: High, lots of fusel oils: Thomas Hardy's; Moderate fusel oils: British Bitter; Low fusel oils: Pilsner Urquell.

OXIDATION

CHARACTERISTICS: Cardboard, paper, wet paper, sherry-like, rotten fruit, garbage are all characteristics of oxidation, perceived both as an aroma and a flavor.

CAUSES: Oxidation of beer and the alcohol component into fusel alcohols, trans-2-nonenal, acetaldehyde.

HIGH LEVEL: Aeration of beer when transferring or bottling; excessive head space in bottle; poorly functioning air lock; excessive age; high storage temperatures; widely-varying secondary or lagering temperatures; adding tap water to finished beer.

LOW LEVEL: Quiet transfer of beer when siphoning and bottling; flushing out bottles and kegs with CO2 before filling and capping; cool (<55 degree) storage of bottled beer; proper head space in bottle; use of ascorbic acid; good airlock; constant-temperature secondary/lagering; adding only boiled/chilled water to beer after primary fermentation.

LIGHT-STRUCK

CHARACTERISTICS: Skunk odor; unmistakable; smells like a road kill skunk; tastes like it smells. Totally undesirable in beer.

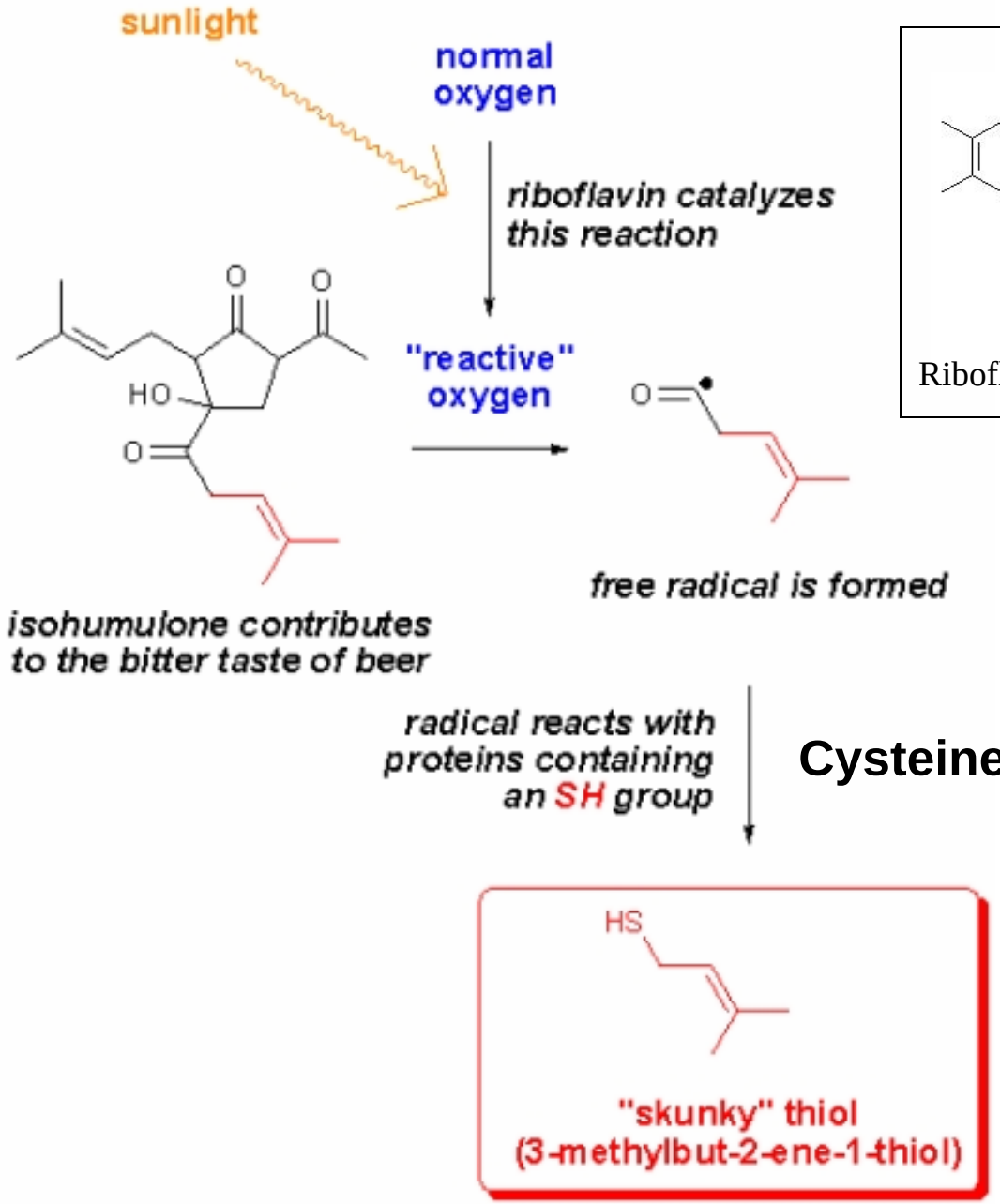
CHEMISTRY: Light will change some of the hop content of the wort to skunklike sulfuric compounds.

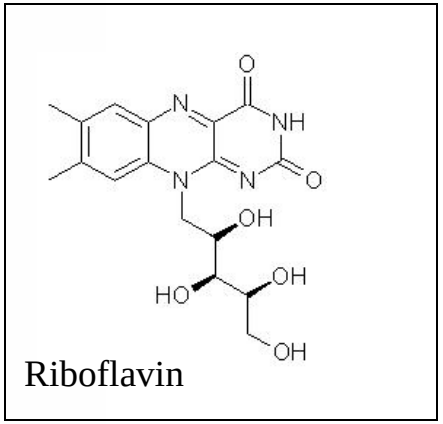
HIGH CONTENT: Light-struck fermenter; clear or green glass bottles; sunlight on brown bottles; bar cooler fluorescent lights on green or clear bottles.

REDUCTION OR ELIMINATION: Fermenter shielded from light; brown or opaque bottles opaque to 400-520 nm light wavelengths; isomerized hop extract; storing beer in a cool, dark place.

EXAMPLES: Any green-bottle Eurolager left in sun for 15 minutes.

Formation of “skunk” thiols from light





Riboflavin

HUSKY-GRAINY/ASTRIGENT

CHARACTERISTICS: A taste spectrum that includes astringent tastes, cereal or grainy tastes, and husky tastes. Unlike bitterness, astringency is present as a stimulation of the nerve endings throughout the mouth. It is not an aroma. The taste is a puckering, dry, unpleasant situation. It is a very acidic, tannic, tart sensation reminiscent of grape skins.

CAUSES: Tannins from grain husks causes the astringent huskiness, while the graininess comes from the starches in the barley malt. Bacterial contamination

INCREASE DUE TO PROCESS: Excessive grain crushing; powdering the malt during crushing; sparge temperature in excess of 170 degrees; excessive sparging; high pH during sparging and mash(above 6.0); boiling grains; improper decoction mashing; improper wetting of grist during mash-in; direct-firing of mash tun without proper stirring; old beer; too many salts in water (sodium, magnesium, sulfate, chloride); iron in water; excessive hopping; high acidity

DECREASE DUE TO PROCESS: Proper crush; slow mash-in; lautering temperatures between 164-170 degrees; monitoring pH of runoff and adding gypsum to keep pH below 6; proper sparge amounts; temperature controlled or infusion mash; steeping adjunct grains (such as crystal malt added to extract brews) below 170 degrees instead of bringing to boil; water appropriate to style; iron-free water.

EXAMPLES: Grainy (appropriate): Stoneys, many Midwestern regional lagers

SOUR-ACIDIC

CHARACTERISTICS: Another of the basic tastes. This is perceived on the sides of the tongue towards the back of the mouth. At higher levels it can be felt all the way down the throat. Generally in beer this is perceived as a sour aroma and a tartness or vinegar like aroma. Bacteria contamination sourness can also be perceived as spoilage or putrefaction.

CHEMISTRY: Caused by lactobacillus, pediococcus, acetobacter and some yeast strains.

HIGH CONTENT DUE TO PROCESS: Poor sanitization; bad yeast strain; too much corn sugar; excessive amounts of citric or ascorbic acid; high fermentation temperatures; excessive acid rest; mashing too long; use of wooden spoon in cooled wort or fermentation; storage at warm temperatures; scratched plastic fermenter.

LOW CONTENT DUE TO PROCESS: Good sanitization; stainless steel equipment and spoons; cool fermentation temperatures; cool beer storage; mashing for not more than two hours; glass carboy fermenter.

DIMETHYL SULFIDE (DMS)/SULFURY-YEASTY

DMS

CHARACTERISTICS: Volatile sulfur-based compounds that can give beer a taste and aroma of cooked corn, celery, cabbage or parsnip to almost oystery-shellfish-like in high concentrations. DMS is first perceived in aroma at around 30 ppb, and the other compounds at considerably lower concentrations..

CAUSES: Wort bacteria (Obesumbacterium, Hafnia, Zymononas, Pectinatus, and Megasphaera). Coliform bacteria strains can also give a strong cooked-vegetable note. Additionally, these compounds can be formed during the kilning of green malt and during mashing. DMS is also formed by the yeast in a normal fermentation

HIGH LEVELS DUE TO PROCESS: Poor sanitation (primary cause); not boiling the wort for at least one hour; long cooling times (overnight) before pitching; underpitching; contaminated yeast (especially packet yeast and recovered sediment); high moisture malt; over-sparging with water below 160 degrees; Under-oxygenation of wort; beer left on sediment for excessive time, Wild yeast contamination.

REDUCTION: Good sanitation; fresh yeast culture; good one hour or more rolling boil; quick wort cooling; high pitching rates; use of 2-row English malt; proper sparging.

FRUITY-ESTERY

CHARACTERISTICS: Aromatic compounds that are identified as fruity and estery in higher amounts. The flavor and aroma of fruits such as strawberry, grapefruit, banana, raspberry, apple and pear and others can appear in beer. Depending on the style, this can be a desired flavor or one totally unsuitable. Ales and high gravity beers are high in fruity-estery content, while pilsners and American lagers are low.

CHEMISTRY: A by-product of fermentation produced by the yeast. Fruity-estery characteristics increase with fermentation temperature.

INCREASE DUE TO PROCESS: Yeast strain used, higher fermentation temperatures, fermenting some lager yeasts at temperatures above 50 degrees, high-gravity wort.

DECREASE DUE TO PROCESS: Yeast strain used, fermenting ales around 60 degrees or less, lagers around 50 degrees or less, lower gravity wort.

EXAMPLES: High: Old Nick Barley Wine; Low: Coors.

PHENOLIC FLAVOR

CHARACTERISTICS: A hospital-medicine chest flavor and aroma. Some phenolic tastes are desired depending on the style. Other descriptions include Band-Aid-like, plasticlike, smoky, clovelike.

HIGH LEVELS DUE TO PROCESS: Yeast strain; chlorophenols in the water; **improper rinse of chlorine sanitizers; oversparging; sparging above pH 6.0; sparging above 170 degrees**; wild yeast contamination.

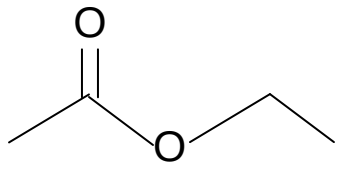
LOW LEVELS DUE TO PROCESS: Charcoal filtering of tap water; good healthy yeast strain; proper sparging while monitoring temperature and pH, good rinse of sanitizers or use of non-chlorine sanitizers.

EXAMPLES: Wheat beers have a high amount of the phenol 4-vinyl guaiacol that gives the characteristic clove taste.

SOLVENT FLAVOR

CHARACTERISTICS: An acetone-like, laquer-thinner-like, pungent, acrid aroma which is followed up by a harsh, burning sensation on the tongue and possibly the back of the throat.

CHEMISTRY: Ethyl acetate in larger quantities (>33 ppm) is the primary cause, either by wild yeast or the yeast strain used.



Ethyl acetate

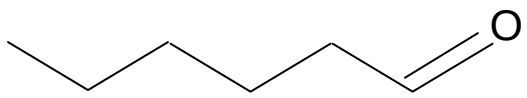
HIGH LEVELS DUE TO PROCESS: Wild yeast contamination due to poor sanitation; **high fermentation temperature**; non-food grade plastic equipment in contact with the beer; open fermenter, especially after high kraeusen subsides; **excessive oxygenation of the wort before pitching**; oxygen in secondary fermenter.

LOW LEVELS DUE TO PROCESS: Good sanitization of equipment; only food-grade plastic used; cooler fermentation temperatures; proper wort oxygenation; closed fermenter.

GRASSY

CHARACTERISTICS: The aroma and flavor of fresh-cut grass

CHEMISTRY: The aldehyde called Hexenal, which is detectable in concentrations of 0.2 ppm.



INCREASE DUE TO PROCESS: Poor quality malt, poor storage of malt, cracking grains well in advance of brewing

DECREASE DUE TO PROCESS: Good, fresh malt stored under airtight conditions; cracking grains the day you brew or the night before.

EXAMPLES: Fresh-cut grass

Back up slides

ASTRINGENT

CHARACTERISTICS: Unlike bitterness, astringency is present as a stimulation of the nerve endings throughout the mouth. It is not an aroma. The taste is a puckering, dry, unpleasant situation. It is a very acidic, tannic, tart sensation reminiscent of grape skins.

CAUSES: Bacterial contamination (lactobacillus and acetobacter); added astringency from grains or hops.

PROCESS: Caused by: poor sanitation; excessive hopping; excessive wort attenuation (small dextrin content) giving greater perception of astringent; boiling grains; excessive grain crushing; too high a lauter run-off temperature (170 degrees max); to much run-off in lautering; letting beer sit too long on trub; non-blowoff primary fermentation; alkaline mash or runoff water; too much sulfate, magnesium or iron; excessively high acidity.

REDUCTION: Process changes to eliminate the above. Crack grain properly, watch mash/runoff pH, 170 degrees maximum for lauter runoff water, use blowoff fermentation; good sanitation practice.

EXAMPLES: Young wine and grape skins; blowout from primary fermentation

BODY

CHARACTERISTICS: Mouth feel (will feel full). A sensation of viscosity in the mouth.

CHEMISTRY: Caused by polysaccharides (dextrins) in the beer that are unfermentable by the yeast.

CAUSES: Caused by presence of unfermentable sugars or dextrins.

INCREASE: Desired in beer. High-temperature (153-160 F) saccharification rest in mash;use of crystal malt and cara-pils malts; use of malto-dextrin, use of lactose.

REDUCTION: Generally not desired. Use of low-temperature saccharification rest in mash, highly-fermentable wort, use of large amounts of corn sugar in wort, long storage, bacterial breakdown, not boiling wort that may have diastase enzymes present.

EXAMPLES: Low: "lite" American beers; High: Samuel Adams