FLAVORS IN BEER

ACETALDEHYDE

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

CHEMISTRY: *Formed as a precursor to alcohol by the yeast, or as a product of the oxidation of alcohol to acetic acid.*

CAUSES: *Acetaldehyde from yeast metabolism as a step in the production of alcohol from glucose has a crisp green apple flavor. If produced from the oxidation of alcohol to acetic acid, whether by oxidation or by acetobacter, this flavor will be more vinegary and less pleasant.*

PROCESS: *As a product of yeast metabolism, it can be caused by the strain itself or by premature termination of the yeast's fermentation. The reaction from glucose to alcohol may be stopped at the acetaldehyde stage by factors such as oxygen depletion, premature flocculation, etc. It may also be produced by contamination by acetic acid bacteria.*

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.*

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. A warming, prickling sensation in the mouth and throat.*

CHEMISTRY: *The end product from the conversion of glucose into carbon dioxide and ethyl alcohol. Other, higher alcohols can also be present, and these fusel oils and contribute to vinous or solventlike aromas and flavors.*

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). Low levels of the dissolved oxygen during the lag phase may also promote the production of higher alcohols due to the metabolization of fatty acids in the trub by the yeast.*

PROCESS: *Composition of the wort, yeast strain and fermentation temperature determines fusel oil concentration.*

REDUCTION: *The amount of alcohol and fusel alcohols should be appropriate for the beer style. Control alcohol by wort start gravity and wort content (avoid large amounts of sugars). Wort should attenuate to about 1/4 of starting gravity. Control fusel oils by reducing the fermentation temperatures and pitching adequate amounts of yeast.*

ASTRINGENCY

CHARACTERISTICS: *Unlike bitterness, astringency is present as a stimulation of the nerve endings throughout the mouth. It is not an aroma. The taste has a puckering, dry, sensation reminiscent of grape skins.*

CAUSES: *Bacterial or wild yeast contamination, added astringency from grains or hops.*

PROCESS: *Caused by: poor sanitation; excessive hopping; excessive wort attenuation (low dextrin content), which gives a greater perception of astringency; boiling grains; excessive grain crushing; high sparge temperatures; over-sparging; letting beer sit too long on trub; alkaline mash or sparge water; too much sulfate, magnesium or iron; excessively high acidity.*

REDUCTION: *Process changes to eliminate the above. Crack grain properly, watch mash/runoff pH, heat sparge water to a maximum of 170 degrees; practice good sanitation*

COLOR

CHARACTERISTICS: *As appropriate for style.*

LIGHTER: *Use of pale malts, use of sugar or adjuncts, filtration.*

DARKER: *Use of higher-temperature kilned malts, use of crystal malt, use of dark malts, carmelization of the boil, hot side aeration and oxidation.*

BITTERNESS

CHARACTERISTICS: *Generally a desired characteristic of hop use. Bitterness will be tasted on the back of the tongue and the roof of the mouth. One of the four basic flavors.*

CAUSES: *Hop content and alpha strength; length of hop boil; presence of dark malts, alkaline water.*

PROCESS: *How long hops are boiled, type of hop, fermentation temperature (high temperature and quick fermentation decrease bitterness), filtration reduces bitterness.*

REDUCTION: *Lower alpha hops, hops added at stages through boil, filtration, high temperature ferment.*

BODY

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

CHEMISTRY: *Caused by the presence of polysaccharides (dextrins) in the beer that are not fermentable by the yeast. Medium length proteins also contribute to palate roundness.*

CAUSES: *Caused by presence of unfermentable sugars or dextrins, often accentuated by diacetyl.*

INCREASE: *Desired in many beer styles. High-temperature saccharification rest in mash; use of crystal malt and cara-pils malts; use of malto-dextrin, use of lactose, adequate protein rest, flaked wheat, oats or barley in the mash.*

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.*

CLARITY

CHARACTERISTICS: *Visual clarity in beer contributes to its appeal.*

INCREASE: *Use of well-flocculating yeast strains; clearing agents such as polyclar, papain, Irish moss, bentonite, gelatin, etc.; filtration; long, vigorous boil and quick chilling; lagering and aging.*

DECREASE: *Weak or mutated yeast strains, non-flocculant yeasts, wheat malt, unmalted barley, poor cold break, poor starch conversion in mash, poor malt crush, bacterial contamination, wild yeast contamination, high protein content due to ineffective proteolytic rest (especially with undermodified malts), tannin present in beer due to excessive or high temperature sparge.*

CARBONATION

CHARACTERISTICS: *The presence of carbonic acid in beer gives the head and bubbles when the bottle is opened and pressure released. Gives head characteristic. Taste is tart and acidic, increasing with the carbonation. This is especially noticeable on overcarbonated brews. An overall prickly or stimulating mouth feel. Small bubbles are desired, as these will retain both the head and the carbonation for a longer period.*

CAUSES: *CO_2 is dissolved in beer during the fermentation process.*

TOO MUCH: *Excessive priming sugars, bacterial contamination, presence of amylase enzymes in bottled beer, iron or calcium oxalate in the water, isomerized hop extract, autolyzed yeast sediment, unconverted starch, not boiling extract worts, fusarium mold on barley or in extract, precipitation of excess salts in the bottle.*

TOO LITTLE: *Poor bottle cap seal, not enough priming sugar, weak or dead yeast culture when bottling (as with long lagering periods or high alcohol beers).*

GRASSY

CHARACTERISTICS: *The aroma and flavor of fresh-cut grass or new-mown hay.*

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. Some English hops also contribute grassy aromas if used in large quantities.*

DECREASE DUE TO PROCESS: *Good, fresh malt stored under airtight conditions; cracking grains shortly before brewing.*

DIACETYL

CHARACTERISTICS: *A butterscotch aroma and flavor, often a slickness on the palate. Not desired in excessive quantities, especially in lagers.*

CAUSES: *A by- product of yeast during fermentation, it is normally re-absorbed during the secondary fermentation. Mutation of yeast can produce respiratory deficient cells which have lost their ability to reduce the diacetyl to more innocuous compounds. Another cause is the gram-positive bacterium, Pediococcus Damnosus and other lactic acid bacteria in cooled beer, young beer, and aging beer. Note that the aroma/taste produced by all of these causes is indistinguishable.*

CHEMISTRY: *One of a family of vicinal diketones. Presence recognized down to 0.05 ppm, but identified at 0.15 ppm. Some tasters are unable to perceive diacetyl even in large concentrations.*

HIGH RATES FROM PROCESS: *Underpitching of yeast; long periods of wort cooling (overnight); contamination from equipment; poor yeast strain; too-soon removal (fining) of yeast (before it can reabsorb the diacetyl); 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 often coexist with yeast in the sediment).*

REDUCTION: *Sanitation, quick wort chilling combined with adequate yeast starter amount (8 ounces of slurry per 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.*

DMS AND RELATED COMPOUNDS

CHARACTERISTICS: *Volatile sulfur-based compounds that can give beer a taste and aroma of cooked corn, celery, cabbage or parsnip and even oystery-shellfish-like in high concentrations. These include dimethyl sulfide (DMS), diethyl sulfide, and di-isopropyl sulfide. DMS is first perceived in aroma at around 30 ppb, and the other compounds at considerably lower concentrations. These compounds are undesirable in beer in high amounts.*

CAUSES: *Wort bacteria (Obesumbacterium or Hafnia) is a major cause, especially of DMS. 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, and during slow cooling of the wort by a non-microbiological chemical reaction.*

HIGH LEVELS DUE TO PROCESS: *Poor sanitation (primary cause); not boiling the wort for at least one hour; covering the brewpot during the boil, 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.*

REDUCTION: *Good sanitation; fresh yeast culture; open, 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, pear and others can appear in beer due to these esters. Depending on the style, this can be a desired flavor or one completely inappropriate. 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.*

FLAVORS IN BEER

HEAD RETENTION

CHARACTERISTICS: *Good head on the beer when poured, not excessively large or small, Belgian lace on glass, head remains for a several minutes. Very much desired.*

CAUSES: *Small bubbles, dextrins, medium molecular weight proteins, isohumulones from hops, nitrogen in wort.*

GOOD HEAD FROM PROCESS: *Use of cara-pils; use of crystal malt; use of malto-dextrin; all-malt beer; good one hour rolling boil to extract the isohumulones from the hops; use of wheat malt; adequate protein rest in the mash to allow the proteolytic enzymes to break down the large proteins into albumin and smaller fractions and increase the nitrogen content; high-temperature saccharification rest; racking to secondary to get beer off sediment; lower temperature fermentation; bottle conditioning.*

POOR HEAD FROM PROCESS: *Use of fully modified malts; use of underkilned malts; not using a one-hour boil; inadequate protein rest, low-temperature saccharification rest; oversparging; yeast autolysis from long sediment contact; excessive fusel oils; higher temperature fermentation; excessive fatty acids; overboiling of wort; insufficient or deteriorated hops; some types of finings.*

POOR HEAD WHEN SERVING: *Soap, detergent or oils on glasses; lip balm, Chapstick or lipstick on lips.*

HUSKY-GRAINY

CHARACTERISTICS: *A taste spectrum that includes astringency cereal or grainy flavors, and huskiness. Generally the grainy notes may or may not be desirable, depending on the style, but the husky astringent tastes are undesired. Husky-grainy is generally perceived as a flavor, although grain notes can be present in the aroma.*

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

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 (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; high mineral content in water (sodium, magnesium, sulfate, chloride).*

DECREASE DUE TO PROCESS: *Proper crush; slow mash-in; lautering temperatures between 164-170°; 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.*

LIGHT-STRUCK

CHARACTERISTICS: *Skunk odor; unmistakable and generally not desirable in beer.*

CHEMISTRY: *Light will degrade hop iso-alpha acids which then combine with sulphur compounds in the beer to produce 3-methyl-2-butene-1-thiol, or prenyl mercaptan. Other sulphur compounds also contribute to the overall lightstruck character.*

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

REDUCTION OR ELIMINATION: *Fermenter shielded from light; use of bottles opaque to 400-520 nm (ultraviolet to blue-green) light; chemically modified hop extract (used by Miller); storing beer in a cool, dark place.*

PHENOLIC

CHARACTERISTICS: *A hospital-medicine chest flavor and aroma, usually detected by its aroma components. Some phenolic tastes are desired depending on the style. Other descriptions include Band-Aid-like, plastic-like, smoky and 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; healthy yeast strain; proper sparging while monitoring temperature and pH, good rinse of sanitizers or use of non-chlorine sanitizers.*

METALLIC

CHARACTERISTICS: *A harsh, metallic taste noted both on the tip of the tongue and the roof of the mouth. Can be felt throughout the tongue and mouth in large concentrations. Not desired in beer. Also described as tinny or bloodlike.*

CHEMISTRY: *The ferrous ion (iron) and some organic compounds formed by hydrolysis of cereal lipids in grain, and oxidization of free fatty acids.*

HIGH RATE FROM PROCESS: *Iron or mild steel in contact with beer; freshly-scrubbed stainless steel that has not been allowed to oxidize (passivation); improper filtering material; high iron content in water; poorly processed grain.*

REDUCTION: *Use of stainless steel; low-iron water; use of citric acid to re-oxidize stainless that has been abrasively cleaned; use of filtering materials that are acid-washed to remove iron; use of fresh, high-quality grain malt.*

MOLDY

CHARACTERISTICS: *A cellarlike, damp-earth, rank cabbagy or moldy bread odor. Not a common defect in beer.*

CAUSES: *Fungal contamination.*

CAUSES DUE TO PROCESS: *Secondary fermentation or transferring beer in a moldy environment, like a cellar. Secondary fermentation or lagering in a moldy cellar where the temperature fluctuates and permits air to be drawn into the carboy. Poor sanitation.*

REMEDIES: *Only expose beer to the air for transferring in a reasonably clean environment. Moldiness smelled in the air is a good indication of an unacceptable environment. Constant-temperature secondary or lagering environment (to prevent air entering carboy). Good sanitation practice.*

NUTTY

CHARACTERISTICS: *An aroma of Brazil nuts, hazelnuts, almonds, or slightly sherry-like. Not necessarily a defect, unless excessive or inappropriate for the style.*

CAUSES: *A product of oxidization or prolonged overheating during aging or after bottling.*

CURES: *Store beer in a 55 degree or less cellar; prevent oxidization or splashing when bottling or racking.*

OXIDATION

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

CAUSES: *Oxidation of beer and the alcohol components into trans-2-nonenal and other aldehydes.*

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 without boiling.*

LOW LEVEL: *Quiet transfer of beer when siphoning and bottling; flushing out bottles and kegs with CO_2 before filling and capping; cool (<55 degree) storage of bottled beer; proper head space in bottle; use of ascorbic acid or oxygen-barrier caps; functional airlock; constant-temperature secondary/lagering; adding only boiled/chilled water to beer after primary fermentation.*

SALTY

CHARACTERISTICS: *Saltiness is one of the four basic taste sensations and is found on the tongue, to either side just behind the tip. Excessive saltiness is not desired in beer for the most part, but fair quantities will be a characteristic of Dortmunder lagers and Burton ales.*

CHEMISTRY: *From sodium chloride, magnesium sulfate and other mineral salts.*

HIGH LEVEL FROM PROCESS: *Excessive addition of Burton salts or table salt or Epsom salts, especially adding these to water already high in mineral salts; water high in sodium chloride or magnesium sulfate.*

LOW LEVEL: *Use salt-free water; do not use or use smaller amounts of added salts, especially Burton water salts.*

SOLVENTLIKE

CHARACTERISTICS: *An acetone-like, lacquer-thinner-like, pungent, acrid aroma which is followed up by a harsh, burning sensation on the tongue and possibly the back of the throat. Not desired in any beer style.*

CHEMISTRY: *Ethyl acetate in larger quantities (>33 ppm) is the primary cause, either by wild yeast or the yeast strain used. Other compounds may also be present.*

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 sanitation of equipment; only food-grade plastic used; cooler fermentation temperatures; proper wort oxygenation; closed fermenter.*

SOUR-ACIDIC

CHARACTERISTICS: *Another of the basic taste sensations, sourness is perceived on the sides of the tongue towards the back of the mouth. At higher levels it can be felt in the throat. Generally in beer this is perceived as a sour aroma and a tartness or vinegarlike aroma. Sourness from bacterial contamination can also be perceived as spoilage or putrefaction.*

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

HIGH CONTENT DUE TO PROCESS: *Poor sanitation; poor yeast strain; excessive amounts of citric or ascorbic acid; high fermentation temperatures; excessive acid rest; mashing too long; storage at warm temperatures; scratched plastic fermenter.*

LOW CONTENT DUE TO PROCESS: *Good sanitation; cool fermentation temperatures; cool beer storage; mashing for less than two hours; glass carboy or stainless steel fermenters.*

SULFURY-YEASTY

CHARACTERISTICS: *Strong sulfuric aroma and taste reminiscent of rotten eggs (hydrogen sulfide), sulfur dioxide, or yeast. Other descriptions include garlic, burnt rubber, shrimp-like, meaty.*

CHEMISTRY: *Formed by amino acids methionine and cysteine in the malt and by certain yeast strains and bacteria, notably Zymononas, Pectinatus, and Megasphaera. Also formed by yeast autolysis.*

HIGH LEVEL IN PROCESS: *Yeast strain; rapid temperature changes to fermenting wort; bacterial contamination; beer left on sediment; wild yeasts; high fermenter back pressure; poor oxygenation of wort at yeast-pitching time; use of metabisulfite in beer; old beer (yeast autolysis).*

LOW LEVEL IN PROCESS: *Good yeast strain; good sanitation practice; racking off sediment before lagering; cooling lagers no more than 5 degrees per day; cold-pitching lagers; strong, healthy active primary fermentation (scrubs out the gaseous sulfur compounds).*

SWEET

CHARACTERISTICS: *The last of the four basic taste sensations, perceived on the tip of the tongue. Desirability dependent on the beer style.*

HIGH LEVELS FROM PROCESS: *Quick flocculating or low attenuating yeast strain; lack of yeast nutrients in wort; poor ferment due to lack of oxygen, yeast nutrient or other flaws; higher gravity wort with low-alcohol tolerant yeast; addition of crystal malt or licorice; high-temperature mash; addition of dextrin malt or malto-dextrin combined with a quick fermentation; addition of sugar and pasteurization; addition of lactose; premature lagering.*

LOW LEVELS FROM PROCESS: *Yeast strain that gives good attenuation; good primary fermentation; lagering, but only after primary fermentation is over; alcohol-tolerant yeast strain; rousing the yeast (without excessively oxygenating it) after sedimentation.*