

Off-Flavors, Part IV

This session covers some faults related to malt, some aspects of aging and process faults.

Almond (Oxidation, Malt)

Detected in: Aroma, Flavor.

Described As: Bitter almond, marzipan, nutty. Also described as Brazil nuts, hazelnuts or other types of tree nuts.

Typical Origins: Aging, specialty grains.

Typical Concentrations in Beer: 1-10 µg/l.

Perception Threshold: 1 mg/l.

Beer Flavor Wheel Number: 0224.

Discussion: An occasional off-flavor in beer which arises due to aging. Similar smelling and tasting compounds might arise due to use of brown or toasted malt. Nutty oxidative notes occur when melanoidins, alcohol and oxygen interact reducing volatile molecules such as esters and hop compounds. They often occur with other oxidative notes such as dark fruit or sherry-like aromas and flavors. These compounds might be reduced back into their original form by oxidizing alcohols into aldehydes.

Also see Catty, Leathery, Oxidation, Papery and Sherry-like.

Increased By: High oxygen levels during mashing and boiling (i.e., Hot Side Aeration - HSA). Carrying hot or cold break into fermenting beer; increasing the amount of fatty acids present in finished beer. Exposing green beer to air during transfer and/or packaging. Excessive air inside storage containers. Non-airtight storage containers. High temperature storage conditions (above ~ 55 °F).

To Avoid or Control: Avoid hot side aeration (don't splash or spray hot mash liquor or wort). Get good hot and cold break. Separate hot and cold break from wort. Don't aerate beer after fermentation starts. Avoid splashing beer during transfer and packaging. Purge conditioning and storage vessels with carbon dioxide before filling them. Don't underfill bottles or kegs. Minimize headspace in bottles (no more than 1-2" below the crown). Get a good seal on bottles and keg. Use anti-oxidant bottle caps and/or wax over caps. Avoid high temperature (90+° F) storage conditions. Keep beer cool (32-50 °F) for long-term storage. Don't age beer unless it can stand up to long-term storage.

When Are Almond (Nutty) Notes Appropriate?: Low levels of nutty notes are acceptable, even welcome, in malt-focused dark beers such as Munich dunkels, English milds, brown ales, and brown porters and American brown ales, as well as dunkelweizens, weizenbocks and old ales.

Dimethyl Sulfide (DMS) (Sulfur)

Detected in: Aroma, Flavor.

Described As: cooked broccoli, cooked corn, cooked vegetable, corn, celery, cabbage, canned vegetables (e.g., canned asparagus), creamed corn, grainy, green beans, parsnips, sea vegetable, seaweed, sulfury, sweet corn, tomato juice, tomato sauce, vegetal, worty. Garlic (in pure form).

At high concentrations it can smell and taste like shellfish or water in which shrimp have been boiled. In pale beer it is usually detected as being corn-like. In darker beer, it can seem more tomato-like or vegetal.

Not to be confused with hydrogen sulfide (rotten egg) or sulfur dioxide (matches).

Typical Origins: Malt, microbial contamination.

Typical Concentrations in Beer: 10 - 150 µg/l.

Perception Threshold: 10 - 150 µg/l, 25-50 µg/l in beer.

Beer Flavor Wheel Number: 0732.

Discussion: Dimethyl sulfide (DMS) is a volatile sulfur-based organic compound derived from S-methyl methionine (SMM) which is an amino acid derivative synthesized when grain germinates during malting. No DMS is produced during germination, though.

SMM levels depend on barley strain and how the grain is malted; British pale ale malt has the lowest SMM levels, while Pils and 6-row lager malts have the highest levels (up to 8 times that of pale ale malt). Drying and kilning the malt at higher temperatures converts some SMM also drives off some DMS, so darker malts have less DMS than paler malts (e.g., the difference between Pils malt and Munich malt). Adjunct grains such as corn also contain high levels of SMM.

SMM is liberated into solution during mashing and is degraded into DMS during wort boiling. The chemical reaction is SMM > Dimethyl Sulfoxide (DMSO) > DMS. Fortunately, DMS is a volatile compound, so it can be driven off during a long, vigorous boil. Since DMS is produced at temperatures below boiling, slow cooling of the wort means that DMS is formed which isn't boiled away. Vigorous fermentation, especially open fermentation, also helps to drive off DMS.

Wild yeast or *Zymomonas* or *Proteus* bacteria may produce high enough DMS levels as to make beer undrinkable, but these also produce other off-flavors such as acetic acid, phenols and other sulfur compounds.

Increased by: * *Malt choice.* Pale, undermodified, continental malts have more SMM than darker, fully modified, UK varieties. SMM is also higher in malt with high moisture content (so store malt in a dry place). High levels of corn-based adjuncts in grist. * *Oversparging at low temperatures (below ~160 °F).* * *Weak or short wort boil* insufficient to drive off DMS. Get a full, rolling boil of at least 90 minutes. Get at least 8% evaporation when using pale lager malts. * *Slow wort cooling.* Don't let hot wort stand. Cool it immediately, as quickly as possible. * *Bacterial or wild yeast infection,* usually by *Obesumbacteria Proteus.* (This bacteria only grows during the lag phase of fermentation, when wort pH is at 4.4 or higher. It can be a problem if fermentation is sluggish or if the lag period is long - 24 hours or more.)

To Avoid or Reduce: * Use good-quality, properly-stored malt. Reduce levels of corn-based adjuncts. * *Keep sparge temperature near 168 °F. Don't collect wort below 1.008 S.G.* * *Vigorous rolling wort boil.* Boil for at least 1-1.5 hours, depending on malts and beer style. Get at least 8% wort evaporation when using pale lager malts. * *Practice good sanitation* (i.e., Avoid cold side use of wooden or scratched plastic utensils/containers). * *Good yeast management.* Pitch sufficient yeast to minimize lag phase (at least 0.5-1 quarts per 5 gallons, more for high gravity beers and lagers). Minimize

yeast shock - match starter gravity & temperature to that of wort.

When is DMS Appropriate?: Low levels are acceptable in light lagers, German pilsner, classic American pilsner, dark American lager, maibock and cream ale.

Grainy

Detected in: Aroma, Flavor.

Described As: Grainy, "green," "green malt," "harsh," husky, nutty.

Typical Origins: Process/equipment faults, Malt.

Typical Concentrations in Beer: <1 - 20 µg/l.

Perception Threshold: 10 µg/l.

Beer Flavor Wheel Number: 0310.

Discussion: Caused by compounds such as isobutyraldehyde which are naturally found in grain husks. As with Polyphenols (see Cloudiness and Phenols) these compounds are extracted from husks due to over-crushing, oversparging, sparging with hot or alkaline water, or excessively long mashes. Higher levels of isobutyraldehyde are found in freshly-made malt which hasn't had sufficient time to rest (2-8 weeks).

To Avoid: * Allow freshly-made malt to rest for sufficient time. * Don't overcrush grains. * Proper mashing and sparging technique. Keep wort and sparge pH in 5.2-5.6 range. Don't collect wort below 1.008 S.G. * Keep mash-out temperature at ~168 °F or less. * Don't mash for more than 2 hours. * Don't expose steeping grains or grain particles to temperatures above ~168 °F. * Don't boil grains or grain husks.

When Are Grainy Notes Appropriate?: Grainy notes at low levels are acceptable in malt-oriented lagers, especially light-colored lagers. They are inappropriate in ales.

Metallic

Detected in: Appearance, Aroma, Flavor, Mouthfeel.

Described As: Bitter, blood-like, bloody, coin-like, coppery, inky, iron-like, rusty, tinny. Metallic ions can cause haze in beer and can affect foam quality.

Typical Origins: Contamination.

Typical Concentrations in Beer: <0.5 mg/l.

Perception Threshold: 1-1.5 mg/l.

Beer Flavor Wheel Number: 1330.

Discussion: While trace amounts of copper, manganese, iron and zinc are necessary for yeast health, detectable levels of metallic ions are rare in beer. When they arise, they are usually due to high levels of metallic ions in brewing liquor or due to ions leached from metallic brewing equipment. Metallic notes might also arise due to products of lipid oxidation, through processes which aren't fully understood. Metallic ions can also promote the formation of other staling compounds. High levels of some metallic ions can also be toxic to yeast.

There is some scientific controversy over whether metallic tastes are properly part of mouthfeel or flavor, and the exact neurological pathways involved in perceiving metallic sensations.

To Avoid: * Properly treat water to remove excess metallic ions. * Don't use fittings, containers or sealants which

are likely to corrode (e.g., iron, mild steel, lead, solder, non-food-grade brazing compounds). * Properly passivate brass fittings used in the brewing process. * To avoid corrosion, don't leave caustic cleansers or sanitizers in prolonged contact with metal fittings, rinse thoroughly and allow equipment to air dry. * Only use stainless steel, food-grade plastic or glass containers to store fermenting wort or finished beer.

When are Metallic Notes Appropriate?: Never.

Vanilla (Phenol)

Detected in: Aroma, Flavor.

Described As: Cream soda, Custard-like, Ice cream.

Typical Origins: Malt, aging, adjuncts, microbial contamination.

Typical Concentrations in Beer: 10-80 µg/l.

Perception Threshold: 40 µg/l.

Beer Flavor Wheel Number: 1003.

Discussion: Vanillin, the active ingredient in vanilla, is formed by the breakdown of lignins, naturally found in plant cell walls, when exposed to alcohol and oxygen. It is formed in some beers, particularly those high in phenols (e.g., tannins) during aging.

Vanilla is also produced during fermentation by strains of yeast ((POF+ strains) which produce phenolic off-flavors, from its precursor, ferulic acid. In such cases, it is usually accompanied by a similar molecule 4-vinyl guaiacol (see Spicy).

In a few cases, vanilla notes might occur as part of a wild yeast infection. Some wild yeasts produce phenolic flavor compounds which are degraded to form vanillin.

To Control or Avoid: * Avoid getting tannins and spicy phenols into beer. Practice good milling and mashing practice to avoid tannin extraction from malt. See Phenols for more suggestions. * Practice good sanitation to avoid wild yeast infection. * Limit contact with wood (both amount of wood used and time spent in contact) when wood-aging beer. * Proper choice of yeast strain - some yeasts produce vanilla-like notes.

When Are Vanilla Notes Appropriate?: Typically beer has trivial amounts of vanillins, so it is considered a fault in most beer styles. Some degree of vanilla character is welcome in wood-aged beers and German wheat and rye beers. Vanilla flavor and aroma might occur in spiced specialty beers.