Ethyl Acetate

**Compound class:** ester

**Flavor Description:** nail polish remover

**Cause:** produced by both ale and lager yeasts in the brewery during fermentation

**Threshold:** 5 – 33 mg/L (8 – 70 mg/L common)

**Avoidance:** cooler ferm temps, controlling FAN levels and increased aeration of wort

**Detection:** Gas Chromatography
Isoamyl Acetate

**Compound class:** ester

**Flavor Description:** estery-fruity...bananas, circus Peanuts, banana-flavored Runts, pear candy

**Cause:** produced by yeast during fermentation, especially characteristic of Belgian and Wit yeast strains. Higher fermentation temps and faster ferm rates will produce more of this ester.

**Threshold:** 1.1 - 1.4 mg/L (0.8 – 6.6 mg/L common)

**Avoidance:** cooler ferm temps and slower rates

**Detection:** Gas Chromatography
Ethyl Hexanoate

**Compound class:** ester

**Flavor Description:** estery-fruity...green apples, fresh fennel, aniseseed

**Cause:** produced by yeast during fermentation, especially ale yeast. “Green” beers tend to have ethyl hexanoate that leans more to the fennel side; properly fermented beers will have more of a green apple character

**Threshold:** 0.2 mg/L (0.07 – 0.5 mg/L common)

**Avoidance:** cooler ferm temps, lower gravity, increase wort aeration

**Detection:** Gas Chromatography
**Diacetyl**

**Compound class:** Vicinal diketone  
**Flavor Description:** buttery, butterscotch flavor and aroma, caramel candy, popcorn, milky, slick/mouthcoating feeling  
**Cause:** produced from a precursor (alpha-acetolactate) formed by yeast during fermentation. It can also be formed by contaminant bacteria such as *Lactobacillus* and *Pediococcus* spp.  
**Threshold:** 10 – 40 µg/L (8 - 600 µg/L common)  
**Avoidance:** complete fermentations, increased sanitation  
**Detection:** Gas Chromatography – Electron Capture Detection
Dimethyl Sulfide (DMS)

**Compound class:** thioether

**Flavor Description:** vegetal + sweet... canned cream corn, canned black olives, tomato sauce

**Cause:** formed from malt-derived precursors (S-methyl methionine and dimethyl sulfoxide) primarily during wort production and can also be the result of bacterial contamination during fermentation

**Threshold:** 30 - 50 µg/L (10 - 150 µg/L common)

**Avoidance:** copper, good boil ventilation

**Detection:** Gas Chromatography
Hydrogen Sulfide

**Compound class:** sulfide

**Flavor Description:** boiled or rotten eggs

**Cause:** produced by both ale and lager yeasts during fermentation and maturation. Can also be formed by contaminant bacteria.

**Threshold:** 4 µg/L (0.001 – 0.2 mg/L common)

**Avoidance:** copper, aging, sanitation

**Detection:** Gas Chromatography, titration
Acetaldehyde

**Compound class:** aldehyde

**Flavor Description:** aldehydic...bruised apples, old cider, emulsion paint

**Cause:** Produced by yeast during fermentation. Can also be caused by high O₂ levels in packaged beer as well as by bacterial contamination.

**Threshold:** 5 - 15 mg/L (2 - 15 mg/L common)

**Avoidance:** healthy fermentation, controlling O₂ during packaging

**Detection:** Gas Chromatography, enzymatic assay
Mercaptan

Compound class: thiol

Flavor Description: drains, rotting garbage, rotten vegetables, leek-like

Cause: arises through yeast autolysis at the end of fermentation or during maturation. It can also be contributed to beer by dry hopping and by growth of bacteria in beer.

Threshold: 1 – 1.5 µg/L (0 – 0.5 µg/L common)

Avoidance: healthy fermentation, transferring beer off yeast, good sanitation

Detection: Gas Chromatography, titration
Lactic Acid

Compound class: organic acid

Flavor Description: lactic, like yogurt or sour milk

Cause: bacterial infection

Threshold: 400 mg/L

Avoidance: healthy fermentation, good sanitation

Detection: Gas Chromatography, titration
Acetic Acid

**Compound class:** organic acid

**Flavor Description:** Vinegar aroma/flavor, acidic, harsh sourness

**Cause:** produced by yeast during fermentation. Too much yeast growth, contaminating bacteria and wild yeasts can all result in production of excessive levels of acetic acid.

**Threshold:** 90 – 130 mg/L (30 – 200 mg/L common)

**Avoidance:** healthy fermentation, good sanitation, clean beer lines

**Detection:** Gas Chromatography, HPLC, enzymatic assay
Isovaleric Acid

**Compound class:** organic acid  
**Flavor Description:** pungent...putrid, old cheese, stale hops, sweaty socks  
**Cause:** derived from breakdown of alpha-acids in hops. It is imparted to beer by use of high hopping rates or degraded hops or hop extracts. Can occasionally be produced by wild yeasts, specifically *Brettanomyces* spp, which may be present either as contaminants or introduced into beer for conditioning purposes.  
**Threshold:** 1 mg/L (0.2 – 1.5 mg/L common)  
**Avoidance:** fresh hops, good sanitation  
**Detection:** Gas Chromatography
Lightstruck

Compound class: thiol

Flavor Description: lightstruck, like a skunk or freshly-brewed coffee

Cause: formed in beer as a result of exposure to daylight or artificial light. This initiates a reaction involving hop bitter acids, vitamins and sulphur compounds. Small amounts are also formed in beer production.

Threshold: 4 – 30 ng/L (1 – 1500 ng/L common)

Avoidance: brown bottles, avoid sunlight, UV

Detection: Gas Chromatography
Trans-2-nonenal

**Compound class:** aldehyde

**Flavor Description:** oxidation...cardboard, newspaper, spit ball

**Cause:** Formed during wort production and beer storage. Development of character depends on time and temp of storage, and $O_2$ content of packaged beer. Lipid oxidation.

**Threshold:** 50 – 250 ng/L (<50 – 200 ng/L common)

**Avoidance:** good storage conditions

**Detection:** Gas Chromatography
4-Ethylphenol

**Compound class:** phenol

**Flavor Description:** barnyard, medicinal, band-aids, and mousy

**Cause:** produced by *Brettanomyces* (*Dekkera*) during barrel aging, and occasionally after bottling.

**Threshold:** 140 – 550 µg/L

**Avoidance:** good sanitation

**Detection:** Gas Chromatography
# The Flavor Challenge

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