

# Beer Off Flavors



Off flavor	<b>Diacetyl (2,3 butanedione)</b>
Flavor Threshold	0.1 – 0.2 mg/L
Aroma/ Taste	buttery, butterscotch, popcorn artificial butter, slick mouthfeel
Cause(s)	Yeast produce $\alpha$ -acetolactate, which leaks into beer, where it's oxidized to diacetyl. Nutrient (valine) deficiency can increase $\alpha$ -acetolactate. Also produced by pediococcus / lactobacillus / (brettanomyces) contamination.
How to Fix	<ul style="list-style-type: none"> <li>- Diacetyl is normally absorbed by yeast</li> <li>- Krausening with fresh active yeast can reduce</li> </ul>
How to Avoid	<ul style="list-style-type: none"> <li>- Allow enough time in fermenter (including after dry hopping (hop creep)) before crashing yeast</li> <li>- Diacetyl rest can accelerate production and absorption</li> <li>- "Appropriate" nutrient levels</li> <li>- Forced diacetyl test</li> <li>- Sanitation</li> </ul>



Off flavor	Acetic Acid
Flavor Threshold	60 – 100 mg/L
Aroma/ Taste	vinegar, sour
Cause(s)	Contamination by: <ul style="list-style-type: none"> <li>- Acetobacter (&amp; oxygen)</li> <li>- Lactobacillus (&amp; (sometimes) oxygen)</li> <li>- Brettanomyces (&amp; oxygen)</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Sanitation</li> <li>- Avoid post fermentation Oxygen</li> <li>- Adequate Hopping can suppress Lactobacillus (variable by strain)</li> </ul>



Off flavor	Diacetyl & Acetic Acid combo
Flavor Threshold	0.1 – 0.2 mg/L & 60 – 100 mg/L
Aroma/ Taste	rancid butter, sour cream, buttermilk
Cause(s)	When found together, the most likely cause is Lactobacillus contamination, or multiple microbes contamination.
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Sanitation</li> <li>- Avoid post fermentation Oxygen</li> <li>- Adequate Hopping can suppress Lactobacillus (variable by strain)</li> </ul>



Off flavor	DMS (Dimethyl Sulfide)
Flavor Threshold	25 – 50 µg/L
Aroma/ Taste	creamed corn, cooked corn, cooked vegetable, oysters, tomato juice, vegetal
Cause(s)	<ul style="list-style-type: none"> <li>- Inadequate boil-off of DMS produced from thermal degradation of precursor S-methyl methionine (SMM) during boil or hopstand. SMM comes from malt, esp. lightly kilned malts.</li> <li>- During ferment, yeast can reduce precursor dimethyl sulfoxide (DMSO, also from malt) to DMS</li> <li>- Contamination: Enterobacter and others can also convert DMSO to DMS</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Adequate boil vigor and times, longer for pilsner malts</li> <li>- Use higher kilned malts (e.g. pale ale malt vs. pilsner)</li> <li>- Sanitation</li> </ul>



Off flavor	Papery/Oxidized (Trans-2-nonenal)
Flavor Threshold	0.1 – 0.25 µg/L
Aroma/ Taste	papery, wet cardboard, stale, cucumber
Cause(s)	<ul style="list-style-type: none"> <li>- Enzymatic oxidation of lipids by Lipxygenase (LOX), both from malt</li> <li>- Non-enzymatic oxidation of linoleic acid (from malt)</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Avoid Oxygen other than at yeast pitch</li> <li>- Vorlauf (i.e. clear wort into kettle)</li> <li>- Consider using a LOX-less base malt</li> <li>- Keep beer cold</li> </ul>



Off flavor	<h1>Acetaldehyde</h1>
Flavor Threshold	10 – 20 mg/L
Aroma/ Taste	green (unripe) apples, cut grass, solventy
Cause(s)	<ul style="list-style-type: none"> <li>- Produced by yeast during the fermentation of glucose (second to last step in the production of ethanol)</li> <li>- Incomplete Fermentation</li> <li>- After fermentation: Oxidation of ethanol to acetaldehyde</li> </ul>
How to Fix	<ul style="list-style-type: none"> <li>- Extend time on yeast before packaging</li> </ul>
How to Avoid	<ul style="list-style-type: none"> <li>- Pitch enough healthy yeast cells</li> <li>- Aerate wort</li> <li>- Don't rush to packaging</li> <li>- Avoid Oxygen other than at yeast pitch</li> </ul>



Off flavor	<p style="text-align: center;"><b>Skunked/Lightstruck</b> <b>(3-methyl-2-butene-thiol)</b></p>
Flavor Threshold	5 – 30 ng/L
Aroma/ Taste	skunk, sulfury
Cause(s)	<ul style="list-style-type: none"> <li>- Produced by light striking Isohumulones from hops 350 – 500 nm wavelength, i.e. Ultraviolet/Blue/Green</li> <li>- Catalyzed by Riboflavin (produced by yeast)</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Avoid light after pitching yeast</li> <li>- Use brown bottles</li> <li>- When outdoors, drink fast (but responsibly)</li> </ul>





Off flavor	Lactic Acid
Flavor Threshold	200 – 400 mg/L
Aroma/ Taste	tart/sour
Cause(s)	Contamination by: <ul style="list-style-type: none"> <li>- Lactobacillus</li> <li>- Pediococcus</li> <li>- some other gram positive bacteria</li> </ul>
How to Fix	- Add Baking Soda or Pickling Lime to finished beer (raises pH)
How to Avoid	- Sanitation - Adequate hopping (iso- $\alpha$ -acids inhibit Lactobacillus)



Off flavor	Metallic
Flavor Threshold	1– 2 mg/L
Aroma/ Taste	iron, rusty, blood, aluminum foil
Cause(s)	<ul style="list-style-type: none"> <li>- Rusty Pipes/Equipment</li> <li>- Bare Aluminum</li> <li>- H<sub>2</sub>O with High Iron Content</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Bring plumbing up to code</li> <li>- Passivate Stainless Equipment</li> <li>- Boil Water in Aluminum Kettles before first use</li> <li>- Brew with RO/Distilled water vs high iron well water</li> </ul>



Off flavor	Isovaleric Acid
Flavor Threshold	0.1 – 1.5 mg/L
Aroma/ Taste	cheesy, gym socks
Cause(s)	<ul style="list-style-type: none"> <li>- Oxidation of Hop Resins</li> <li>- Brettanomyces contamination</li> </ul>
How to Fix	<ul style="list-style-type: none"> <li>- If caused by Brett (or if Brett is simply present), aging may allow Brett to break it down into ethyl isovalerate, a berry-like ester.</li> </ul>
How to Avoid	<ul style="list-style-type: none"> <li>- Store hops cold, vacuum sealed/nitrogen flushed</li> <li>- Avoid older hops</li> <li>- Sanitation</li> </ul>



Off flavor	H <sub>2</sub> S (Hydrogen sulfide)
Flavor Threshold	4 µg/L
Aroma/ Taste	rotten eggs, sewer
Cause(s)	<ul style="list-style-type: none"> <li>- Produced (and usually cleaned up) by Yeast</li> <li>- Nitrogen Deficiency</li> <li>- Low Yeast Pitch Rates</li> <li>- Excess SO<sub>2</sub> (e.g. from Metabisulfites)</li> </ul>
How to Fix	<ul style="list-style-type: none"> <li>- Time. O<sub>2</sub>, and/or some trace metals like Copper, in finished beer will react with and decrease H<sub>2</sub>S</li> <li>- Stir with Copper (last resort)</li> </ul>
How to Avoid	<ul style="list-style-type: none"> <li>- Avoid Underpitching</li> <li>- Add Yeast Nutrients (nitrogen)</li> <li>- Avoid excessive Metabisulfite additions</li> </ul>



Off flavor	Ethyl Mercaptan (Ethanethiol)
Flavor Threshold	4.5 µg/L
Aroma/ Taste	onion, garlic, rotten cabbage
Cause(s)	<ul style="list-style-type: none"> <li>- Yeast Autolysis</li> <li>- Dry Hopping</li> </ul>
How to Fix	n/a
How to Avoid	<ul style="list-style-type: none"> <li>- Pitch Healthy Yeast</li> <li>- Limit beer contact time with Trub (inactive yeast)</li> <li>- Limit Dry Hop Quantities and Contact Time</li> </ul>

