External risks to beer flavor quality

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Overview

- External flavor defects
- Origins
- Examples
- Case studies
# Types of flavor detects

<table>
<thead>
<tr>
<th><strong>Off-flavor</strong></th>
<th>An ‘atypical’ flavor generated within the product by chemical or biological reactions - often present in ‘sound’ product, but at acceptable levels</th>
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</thead>
<tbody>
<tr>
<td><strong>Taint</strong></td>
<td>A flavor contributed to the product from an external source <em>via</em> a ‘vector’ – usually absent from ‘sound’ product</td>
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</tbody>
</table>
Some compounds can cause product recalls when present at <10 ng/l in the final product.
Consumer impact

1. “It’s different”
2. “It’s not quite right”
3. “I’m not sure I like this”
4. “There’s something wrong here”
5. “I’m worried”
6. “Help!”
Examples of external flavor defects
Chlorophenol, antiseptic, mouthwash

2,6-Dichlorophenol

200 ng/l
Formed as a by-product of disinfection of water with chlorine

OriGin

Chlorophenol
Reaction between chlorine and phenolic compounds in water – activated carbon filters used to remove chlorine in the brewery can contribute to chlorophenol formation when they are not looked after.
Ensure chlorine concentrations in incoming water are not too low – regularly backflush and clean activated carbon filters – taste brewery water every day using trained tasters.
trans-2-Nonenal 

Papery

200 ng/l

Dry paper, dry cardboard
Unsaturated lipids, such as linoleic acid, found in malted barley
Oxidation of fatty acids by O$_2$, either through the action of lipoxygenase, or non-enzymically – nonenal formed binds to proteins during wort boiling and is released after packaging of beer.
Adjust brewhouse procedures to minimize opportunities for LOX activity – ensure adequate production of $\text{SO}_2$ by yeast during fermentation – maximize beer pH consistent with good brewing practice
Grape

2-Aminoaceto-phenone

1 µg/l

Grape, tortilla chips
Maize used to produce glucose, fructose and high-maltose sugar syrups
Degradation of the amino acid tryptophan during alkaline treatment of maize leads to formation of 2-aminoacetophenone (2-AP) – if this is not removed, the syrup will impart this flavor to beer.
Minimize 2-AP formation by good maize milling practice – remove 2-AP with activated carbon prior to concentration of the syrup – taste every batch of sugar syrup coming into the brewery to ensure the absence of 2-AP
Isovaleric acid

Isovaleric

acid

Cheese, sweat

1 mg/l
Humulone found in hops breaks down and releases isovaleric acid (cohumulone and adhumulone break down to give different fatty acids of lower flavor impact).
Chemical breakdown of humulone due to prolonged storage of hops at excessive temperatures leads to formation of isovaleric acid – the more hop material used to make beer, the greater the contribution of isovaleric acid.
PREVENTION

Store hops and hop products at lowest possible temperature to minimize isovaleric acid formation – avoid use of old hops or hop products

Isovaleric
Phenolic – 4-VG

4-Vinyl guaiacol

300 µg/l

Plastics

Styrene

20 µg/l
Saccharomyces wild yeasts present as contaminants in pitching yeast

Phenolic – 4-VG

Plastics
Precursors derived from cereals are converted to 4-VG, styrene and other phenolics due to the activity of phenyl acrylate decarboxylase – worts with low temperature mash stands are most at risk.
Check all yeast cultures for the presence of "phenolic yeasts" – use cultures which have been proven to be free of wild *Saccharomyces*.
Dimethyl sulfide

CO$_2$

DMS

30 µg/l

Sweetcorn, ketchup, truffles
In addition to originating in malt, DMS can be contributed to beer by contaminated CO₂
Use of CO$_2$ which has not been sufficiently purified prior to addition to beer

DMS
Ensure that incoming supplies of CO\textsubscript{2} are screened for the absence of flavor defects – bubble through odourless water then have trained tasters evaluate them – ensure that suppliers carbon-filter CO\textsubscript{2} and manage the carbon to assure effectiveness.
FILTER AID

Musty

2,4,6-Trichloroanisole

500 ng/l

Musty, mouldy, cork taint

2017 ASBC Meeting
FILTER AID

ORIGIN

External contamination - taint

Musty
Molds growing in the environment convert chlorophenols into chloroanisoles – these compounds are adsorbed onto filter aid – when that filter aid is used to filter beer, the beer becomes contaminated with musty flavor.
Check every batch of filter aid supplied to the brewery to ensure the absence of musty flavors – use trained tasters who are competent in detection of haloanisoles (chloroanisoles and bromoanisoles)
Bromophenol

2-Bromo-phenol

Medicinal, antiseptic, inky

100 ng/l
Present in recycled cardboard and transferred to packaging materials prior to use

Bromophenol
Bromophenols are used as fire retardants and as wood preservatives – they contaminate recycled cardboard and paper – such compounds get into beer as a result of contact with packaging materials.
Screen all incoming packaging materials for the presence of taints – pay particular attention to paper and cardboard liners used to separate cans or bottles from one another

Bromophenol
Case studies
Case study #1

Ingredient: malt
Product: beer
Flavor defect: ‘chemical’

- Detected by only 1 in 8 tasters in the brewery
- Source identified as a barley storage pesticide (carbaryl) present in the malted barley used to make the beer - carbaryl converted to 1-napthol by yeast during fermentation of the beer
- Largest product recall in history of the brewing industry up until that time
- **Action**: use of carbaryl on malting barley banned
Case study #2

Ingredient: yeast hulls (ghosts)
Product: wine
Flavor defect: medicinal

- ‘Yeast hulls’ used by winemakers to reduce the incidence of ‘stuck’ fermentations
- Hulls were contaminated with 2-chloro-6-methyl-phenol which imparted a medicinal note to wine
- Industry-wide lawsuit initiated - court ruled in favour of the supplier, saying that users should have tested the product to ensure fitness for purpose
- Action: not known
Case study #3

Ingredient: carbon dioxide (CO$_2$)

Product: carbonated soft drinks

Flavor defect: ‘chemical’

△ Caused ‘illness’ and mass hospitalizations (children) – later regarded as psychosomatic

△ Product withdrawn from several European markets

△ Wiped billions off the Company’s share price

△ Traced to sulfur compounds in CO$_2$ gas used as an ingredient

Action: sensory assessment of all CO$_2$ supplies
Risk management

- Taste all ingredients on receipt – multiple assessors needed
- Pay attention to transport and storage conditions
- Maintain a library of retained samples to aid troubleshooting
- Make sure that supplier contracts deal with the issue of flavor risks
During production, the beers we make are exposed to a range of external risks to flavor quality.

Through awareness of the main risks we can put in place procedures to protect against such problems.

Trained, competent tasters are the first line of defense.

Taste early and often, since prevention is preferable to cure.