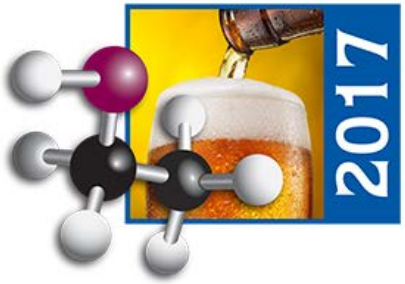
External risks to beer flavor quality

Amaey J Mundkur and Dr Bill Simpson
Cara Technology, UK



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TECHNOLOGY

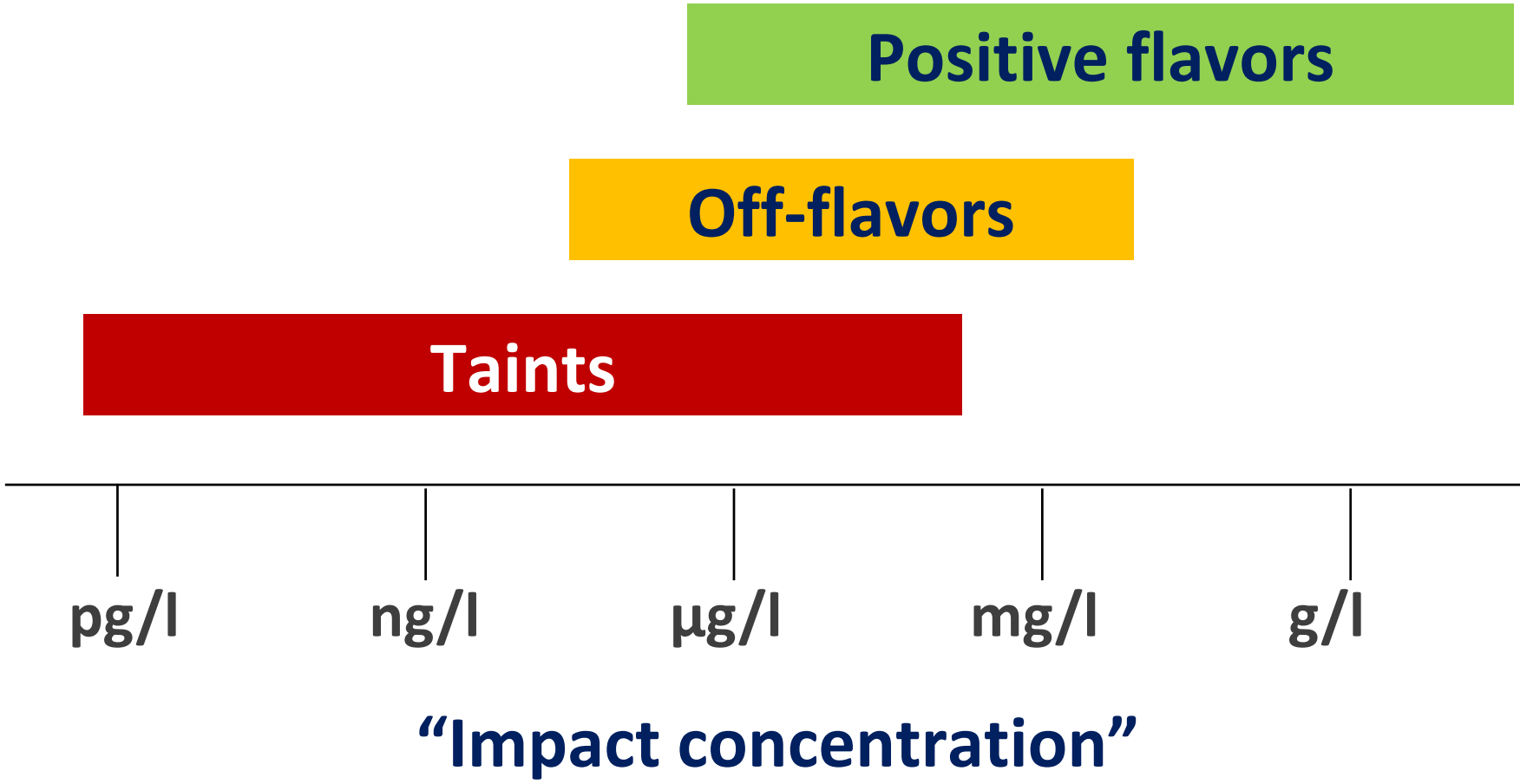
Overview

- External flavor defects
- Origins
- Examples
- Case studies

Types of flavor detects

Off-flavor	An 'atypical' flavor generated within the product by chemical or biological reactions - often present in 'sound' product, but at acceptable levels
Taint	A flavor contributed to the product from an external source *via* a 'vector' – usually absent from 'sound' product

Flavor impact

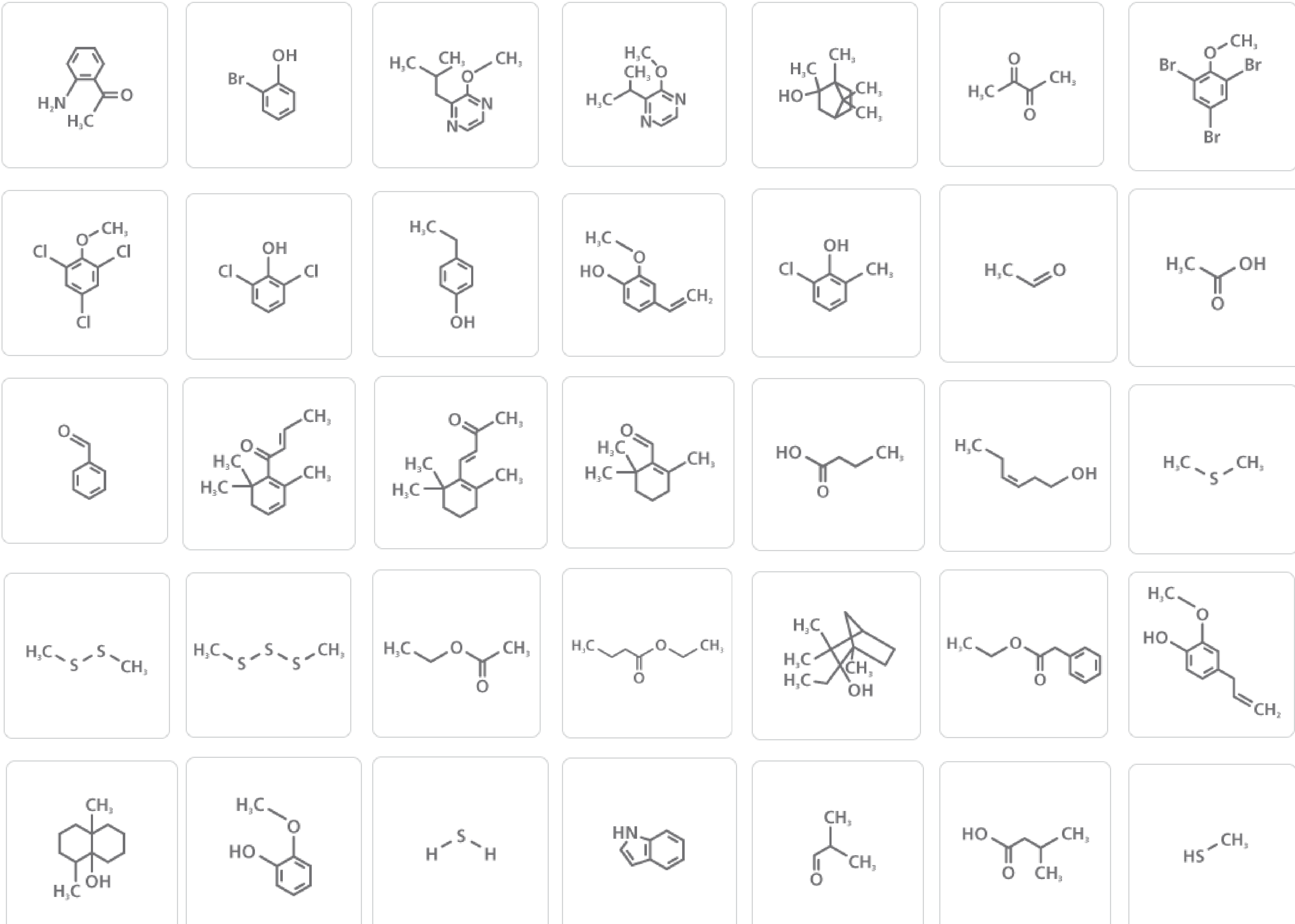


Some compounds can cause product recalls when present at <10 ng/l in the final product

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!”

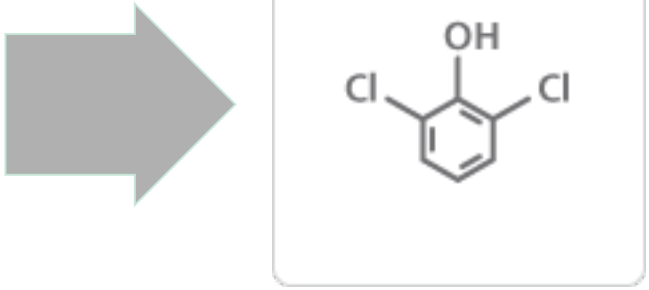
Examples of external flavor defects



WATER

Chlorophenol

2,6-Dichloro-phenol



Chlorophenol, antiseptic, mouthwash

200 ng/l

WATER

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ORIGIN

Formed as a by-product of disinfection of water with chlorine

Chlorophenol

WATER

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CAUSE

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

Chlorophenol

WATER

PREVENTION

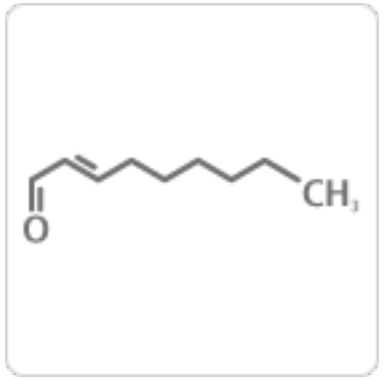
Ensure chlorine concentrations in incoming water are not too low – regularly backflush and clean activated carbon filters – taste brewery water every day using trained tasters

Chlorophenol

MALT

Papery

trans-2-Nonenal



Dry paper, dry cardboard

200 ng/l

MALT

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ORIGIN

Unsaturated lipids, such as linoleic acid, found in malted barley

Papery

MALT

CAUSE

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

Papery

MALT

PREVENTION

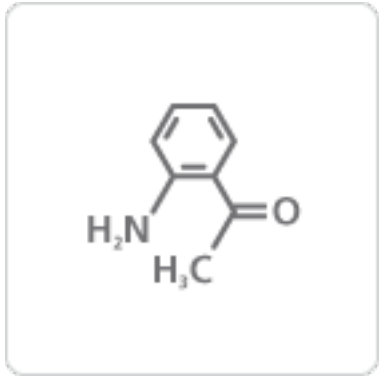
Adjust brewhouse procedures to minimize opportunities for LOX activity – ensure adequate production of SO_2 by yeast during fermentation – maximize beer pH consistent with good brewing practice

Papery

ADJUNCTS

Grape

2-Aminoaceto-phenone



Grape, tortilla chips

1 µg/l

ADJUNCTS

ORIGIN

Maize used to produce glucose, fructose and high-maltose sugar syrups

Grape

ADJUNCTS

CAUSE

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

Grape

ADJUNCTS

PREVENTION

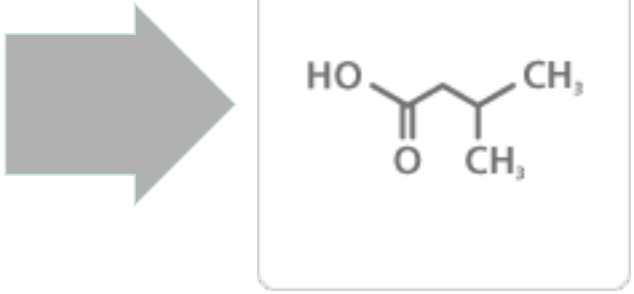
Minimize 2-AP formation by good maize milling practice – remove 2-AP with activated carbon prior to concentration of the syrup – taste every batch of sugar syrup coming into the brewery to ensure the absence of 2-AP

Grape

HOPS

Isovaleric

Isovaleric acid



Cheese, sweat

1 mg/l

HOPS

ORIGIN

Humulone found in hops breaks down and releases isovaleric acid (cohumulone and adhumulone break down to give different fatty acids of lower flavor impact)

Isovaleric

HOPS

CAUSE

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

Isovaleric

HOPS

PREVENTION

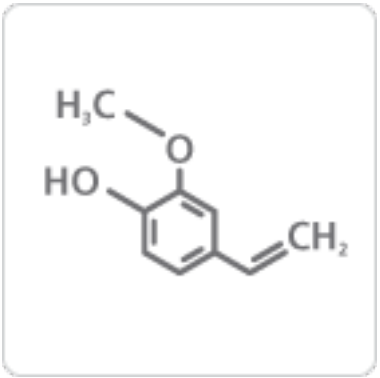
Store hops and hop products at lowest possible temperature to minimize isovaleric acid formation – avoid use of old hops or hop products

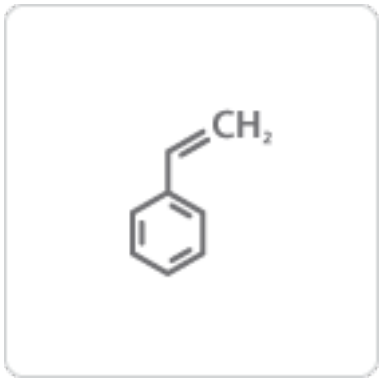
Isovaleric

YEAST

Phenolic – 4-VG

Plastics





4-Vinyl guaiacol

300 µg/l

20 µg/l

Styrene

YEAST

ORIGIN

***Saccharomyces* wild yeasts present as contaminants in pitching yeast**

Phenolic – 4-VG

Plastics

YEAST

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CAUSE

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

Phenolic – 4-VG

Plastics

YEAST

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PREVENTION

Check all yeast cultures for the presence of "phenolic yeasts" – use cultures which have been proven to be free of wild *Saccharomyces*

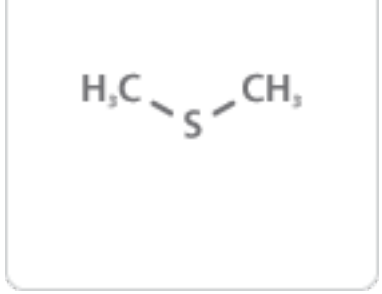
Phenolic – 4-VG

Plastics

CO_2

DMS

Dimethyl sulfide



Sweetcorn, ketchup, truffles

30 µg/l

CO_2

ORIGIN

In addition to originating in malt, DMS can be contributed to beer by contaminated CO_2

DMS

CO_2

CAUSE

Use of CO_2 which has not been sufficiently purified prior to addition to beer

DMS

CO_2

PREVENTION

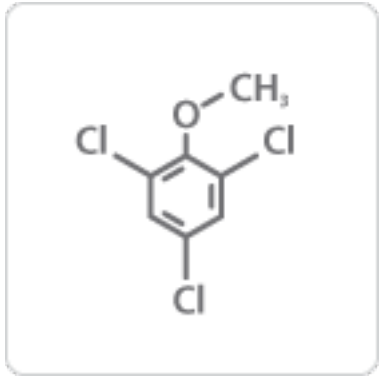
Ensure that incoming supplies of CO_2 are screened for the absence of flavor defects – bubble through odourless water then have trained tasters evaluate them – ensure that suppliers carbon-filter CO_2 and manage the carbon to assure effectiveness

DMS

FILTER AID

Musty

2,4,6-Trichloro-anisole



Musty, mouldy, cork taint

500 ng/l

FILTER AID

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ORIGIN

External contamination - taint

Musty

FILTER AID

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CAUSE

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

Musty

FILTER AID

PREVENTION

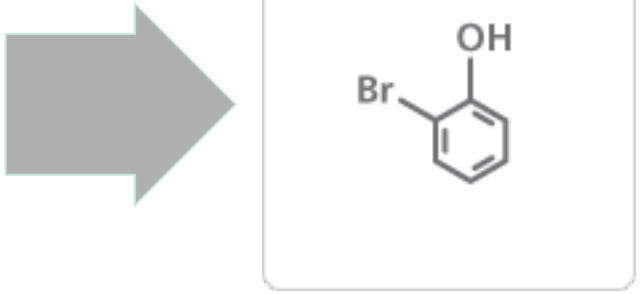
Check every batch of filter aid supplied to the brewery to ensure the absence of musty flavors – use trained tasters who are competent in detection of haloanisoles (chloroanisoles and bromoanisoles)

Musty

PACKAGING MATERIALS

Bromophenol

2-Bromo-phenol



Medicinal, antiseptic, inky

100 ng/l

PACKAGING MATERIALS

ORIGIN

Present in recycled cardboard and transferred to packaging materials prior to use

Bromophenol

PACKAGING MATERIALS

CAUSE

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

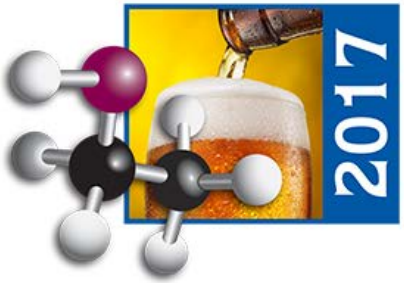
Bromophenol

PACKAGING MATERIALS

PREVENTION

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



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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

Summary and conclusions

- 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