There are many different types of wine defects, many of which overlap due to complex relationships…
- Chemical
- Microbial
- Sulfur-related
- Taint

Origin and description of wine sensory defects

What you can do to prevent defects
• **Wine defect**: an attribute not wanted in the wine

• **Value judgment**
  • Some people may like the “defect”: Acetic, 4EP/EG at low levels add complexity

• **Threshold and tolerance vary among individuals**
Can you *detect* the aroma in question?

Does the attribute alter the *balance* (and therefore your enjoyment) of the wine?

If the answer is “yes” to both questions → you *probably* have a wine defect!

Realities of wine defects

– Personal preferences and styles differ
– Detection of attributes differ
– Interpretation of attributes differ
– Interactive affects of attributes in the bottle and/or glass are profound
• Hazes, Clouds, Sediments, Dust
  – Growth of oxidative yeast or bacteria cause sediment, gas, haze
  – Heat-unstable proteins, clouds and haze
  – Crystals (tartrates, etc.) calcium
  – Iron casse (blue haze)
  – Bottling is a harsh activity! Cork dust, pieces of cork
WINE SENSORY DEFECTS

Visual Defects

- Precipitation of Tartaric Acid
  - Potassium bitartrate instability (needs tartaric acid, ethanol, cold temp, removal of proteins)
  - Calcium tartrate instability (to a lesser extent)
Chemical Browning in White Wines

Oxidation of phenolic compounds (catechins to leucoanthocyanidins)

3 mechanisms:
Carmelization, Maillard Rxn, Direct phenolic oxidation

Prevent oxidation by keeping wine vessels topped up and properly sulfured! Winemaking begins at crush, and with oxygen management, you can clean out any oxidizable phenolic compounds before fermentation.
**WINE SENSORY DEFECTS**

**Visual Defects**

- **Pinking**
  - Found primarily in Sauvignon Blanc and Pinot Grigio, but can be in any white wine
  - Seems to be linked with oxygen exposure, but direct cause unknown
  - Formed when wine stored under reductive conditions suddenly exposed to oxygen. There is a rapid conversion of flavenes to their red flavylidium salts.
    - Use PVPP to fix

- **Lacquering: color pigment instability**
  - A deposit forms in the bottle while in the cellar
  - Primarily found in young red wines (especially Syrah)
  - pH plays a role
  - Products available to prevent color instability
Oxidation (Acetaldehyde)

*Smells like:* Over-ripe bruised apples, Sherry, Nut-like

*Comes from:*
- Wine aging (chemical oxidation of ethanol)
- Associated with:
  - Increased color depth in white wines
  - Brickish tint in red wines
- Improperly stored wines
  - Surface (flor or film) yeast growing aerobically may oxidize ethanol to acetaldehyde
  - Growth of oxidative bacteria on wine surface
  - Excessive heat during storage

Detection:
- Flor Sherry is 500mg/L
- New wine: <75mg/L
- Sensory: 100 – 125 mg/L
• **Volatile Acidity (VA)**
  – Smells like:
    • Vinegar (acetic acid)
      – Has a “rotting” odor
      – “Acetic aroma” not exclusively a result of acetic acid → complexed with ethyl acetate
    • Fingernail polish or Fingernail polish remover (ethyl acetate), contributes significantly to VA defect
      – More pungent than acetic acid
      – Lower aroma threshold
**WINE SENSORY DEFECTS**

**Aroma Defects**

- **Volatile Acidity (VA) sources:**
  - **Yeast**
    - Many non-*Saccharomyces* strains able to produce relatively large amounts of acetic acid and esters
    - Cold soak is a common source associated with VA, wild yeast
  - **Bacteria**
    - Lactic Acid Bacteria during primary and secondary fermentations. VA is harder to detect because it is acetic acid without ethyl acetate esters
    - Immediately treat with lysozyme to inhibit formation of VA
    - Stabilize with SO2 soon after MLF
    - Acetic Acid Bacteria, produces ethyl acetate so easier to detect, can be controlled with sulfur and oxygen management.
• Sulfur
  – From a sensory standpoint, volatile sulfur compounds typically have intense, disagreeable odors (rubbery, skunk, onion…)
  – Sulfur can be sensed in a variety of forms:
    • Sulfate (SO$_4^{2-}$)
    • Sulfite (SO$_3^{2-}$)
    • Amino Acids (methionine, cysteine)
    • Mercaptans
• Sulfur
  – Concentration of sulfur in grape juice (ranges from 100 – 700mg/L) at harvest, depends on:
    • Grape variety, Soil, Nutrient content, Vintage
  – Can somewhat control sulfur product with YAN levels
  – Yeast need sulfur for protein synthesis, vitamins and to support cell growth, but must reduce it to be useful (5mg/L)
  – During fermentation, the reduction of sulfates can form H₂S (yeast, temp)
• Sulfur
  – Volatile sulfur compounds that elicit a sensory response:
    • Sulfur dioxide (Burnt Match), added during winemaking and synthesized by yeast during ALF
    • Hydrogen sulfide (Rotten Eggs), comes from elemental sulfur, yeast, and yeast strain during fermentation (low vs. high H2S producers)
    • Sulfides and Thiols/Mercaptans
      – Methyl Mercaptan
      – Ethyl Mercaptan
      – DMS
      – DMDS
      – Diethyl Disulfide
• Hydrogen Sulfide
  – Concentration depends on:
    • Type and amount of elemental sulfur used on grapes, and timing of applications
    • Yeast strain genetics (low vs. high \( \text{H}_2\text{S} \) producers; rate of fermentation) *Wild yeast, rapid fermenters (Montrachet, UCD 522).*
    • Juice chemistry (pH, YAN, Ethanol concentration, levels of sulfite and sulfate, metal ions, vitamin concentrations, Nitrogen concentrations, methionine concentrations)
    • Physical parameters (suspended solids, fermentation temperature) less \( \text{H}_2\text{S} \) at lower temps
    • Environmental factors (tank height, redox potential)
• **Hydrogen Sulfide**
  – Formation of $\text{H}_2\text{S}$:
    • **Quick Fermentation** (2-4 days): due to Nitrogen imbalance
    • **Late/End Fermentation**: due to degradation of S-containing compounds or Ethanol tolerance
    • **Sur lie aging**: due to yeast autolysis, fatty acids can be extremely odorous
  • If not managed properly, can turn to Mercaptans…
• **Mercaptans**
  • Smells like: Cabbage, Rubbery, Struck Flint or Burnt Rubber
    – Dangers of:
      • Hydrogen Sulfide can react with other wine components to form Mercaptans
      • Difficult to remove from wine, copper won’t help
      • Have a more rotten aroma than $\text{H}_2\text{S}$, very odorous
    – Formation:
      • Emerge later in fermentation and sur lie aging
      • These are released during yeast stationary phases
      • S-containing amino acid degradation
Aroma Defects

- Methanethiol (Methyl Mercaptan) “lightstruck”
  - Smells like: Cooked cabbage, Onion, Putrefaction, Rubber

- Ethanethiol (Ethyl Mercaptan) 1.1ppb
  - Smells like: Onion, Rubber, Natural Gas

- Dimethyl Sulfide (DMS) 25ppb
  - Smells like: Asparagus, Canned Corn, Molasses
  - Not related to H2S production

- Diethyl Sulfide 0.92ppb
  - Smells like: Cooked Vegetables, Onion, Garlic
  - Not related to H2S production

- Dimethyl Disulfide (DMDS) 29ppb
  - Smells like: Onion, Cooked Cabbage

- Diethyl Disulfide 4.3 ppb
  - Smells like: Burnt Rubber, Garlic
**Sulfur Compounds**

**A Lesson Learned:**
- Sulfur compounds have a lot of commonalities, but you have to determine whether you can treat them or not.
- Treat sulfides and mercaptans with copper. Dimethyl Sulfide, Diethyl Sulfide, DMDS and DEDS do not react with copper. Products like Tanenol Max Nature (an oak-derived tannin) work well in conjunction with copper to remove off-aromas. Remember! Some thiol compounds, at lower concentrations, contribute to pleasant, fruity aromas.
- Cork Taint (Corked)
  - Smells like:
    - Musty
    - Swampy
    - Moldy
    - Dank Cellar
    - Wet Newspaper
• Cork Taint or “Corked”: Primarily recognized as TCA (2,4,6-Trichloroanisole)
  – Comes from:
    • Mold on the cork wood
    • Chlorine washing
    • Cellar contamination
  – Chloroanisoles are not naturally occurring in wine
  – Wine contamination requires contact with contaminated material (wood pallets!)
    • Contact of wood with chlorine
    • Mold activity
    • Bentonite susceptible to TCA contamination
• Cork Taint (Corked)
  – TCA – compound mostly associated with cork taint
  – Other compounds:
    • Geosmin (earthy, muddy, cooked beets)
    • 2-Methylisoborneol (2-MIB) (moldy, dirt)
    • 2-Methoxy-3,5-dimethylpyrazine (MDMP)
    • Tribromoanisole (stronger than TCA)
**Aroma/Taste Defects**

- **Brettanomyces Dekkera (Brett.)**
  - Smells like:
    - Barnyard
    - Pharmaceutical (medicine chest, Band-Aid)
    - Horse (blanket, sweat, saddle)
    - Wet Dog
    - Tar
    - Leather
    - Tobacco
    - Plastic
    - Creosote
Brettanomyces Dekkera (Brett.)

- Impact Compounds Associated with Brett.

  - 4-ethylphenol (medicinal, Band-Aid) $500\text{ppb}$
  - 4-ethylguaiacol (smoky, bacon) $50 – 100\text{ppb}$
  - Isovaleric Acid (vomit, sour, cheesey)
WINE SENSORY DEFECTS

Aroma Defects

- Brettanomyces Dekkera (Brett.)
  - Many compounding problems with Brett
    - Spoilage yeast sources
      - Air?
      - Grapes?
      - Cellar (surfaces, equipment)
      - Cooperage
    - Bacteria – *Pediococcus* – can produce small amounts of 4EP/4EG, but not really a factor.
• **Brettanomyces Dekkera (Brett.)**
  – Why is Brett so difficult to prevent?
    • Most strains are resistant to acid
    • Tolerates high ethanol, and many strains use ethanol as a carbon source
    • Slow growth makes it resistant to SO₂
    • Grows on substrates *Saccharomyces* will not utilize (ethanol, amino acids, wood sugars, fructose, etc.)
    • Difficult to destroy with sanitation practices (due to biofilm formation)
• **Methoxypyrazines**
  – Smells like: Green, Grassy, Vegetative, Herbaceous, Bell Pepper (IBMP, IPMP)
  – Comes from:
    • Varietal character (Cabernet Sauvignon, Cabernet Franc, Sauvignon Blanc, Merlot, Semillion, and Carmenere)
    • Unripe fruit
    • Climate
    • Poor production practices
WINE SENSORY DEFECTS

Aroma Defects

• Methoxypyrazines
  – Some of the compounds that contribute to vegetative aromas: $C_{13}$-norisoprenoids, $C_6$-compounds, and S-compounds
  – control immediately as juice with Ascorbic and Sulfur (AST)
WINE SENSORY DEFECTS

Aroma Defects

• “Lightstruck”
  – Smells like: Skunk, Cheese, Plastic
  – Comes from:
    • Amino acid, methionine, rearrangement

Methionine →

H₂S, DMS, Methanethiol, DMDS, Ethyl Methyl Sulfide
• “Lightstruck”
  – Particular problem in sparkling wines
  • Aroma perception magnified by CO$_2$

http://i.telegraph.co.uk/telegraph/multimedia/archive/01385/champagne_cork_1385836c.jpg
• **Mousey**
  - Smells like (and exhibits an aftertaste of): Mouse Urine, Rancid Nuts
  - Comes from:
    - *Lactobacillus*, and sometimes *Oenococcus*
    - *Brettanomyces* (rarely)
  - Main compound responsible for:
    - 2-acetyl-3,4,5,6-tetrahydropyridine
    - Produced in the presence of lysine and ethanol
  - Other Microbial Aromas: Muddy, earthy, musty, beets, turnip
**Smoke Taint**

- Smells like:
  - Smokey
  - Burnt Toast
  - Earthy
  - Smoked Meat
  - Burnt
  - Tobacco
  - Beet Root
  - Drying
  - Ashes
  - Cigar Box

- Smells like:
  - Truffle
  - Charcoal
  - Ash Tray
  - Charred
  - Fungal
  - Tar
  - Bacon
  - Roast Meat
  - Leather
  - Salami
  - Coffee
  - Chocolate
  - Disinfectant
• **Smoke Taint**
  – Comes from:
  • Exposure of smoke to the grape berries
    – Dependent on timing of smoke exposure (most sensitive 7 days post veraison)
    – “Smoke Taint” aroma/flavor compounds appear to be present in grape as glycosides, suggesting berry metabolism of smoke components. Hard to test due to compounds being bonded with sugars.

Ranges: guaiacol – most 5-50 ppb (Few really high >150 ppb)
4-methylguaiacol - <5 ppb to 50-60 ppb high range
4-ethyl guaiacol and 4-ethyl phenol at low levels with 4-ethyl guaiacol conc. greater than 4-ethylphenol
• Over-Extraction
  – Mouthfeel attributes:
    • Excessive Bitterness
    • Excessive Astringency
  – Comes from:
    • Extracting too much tannin during pressing
    • Excessive astringency
A sensory reminder…

– Just because you don’t smell (or taste) something “bad,” it doesn’t mean that the compound(s) is (are) not present in the wine…

– The concentration of the compounds may be below your individual level of sensitivity

OR

– The compounds have not yet combined with others to form the noticeable off-aromas or off-flavors