How to Recognize and Teach Wine Faults

with Tim Gaiser, MS
January 21, 2015

Today’s Objectives

• Survey of major wine faults by category
  • Defining each fault
  • Tracing its origin
  • Markers for identification
  • Possible treatment

Importance of Knowing Major Wine Faults

• Vital component to overall wine knowledge
• Necessary to learn for the professional taster
• Important for the wine instructor
• Critical asset for the wine buyer
Wine Faults by Source

- Environmental: TCA, Maderized, Lightstrike
- Microbial: Brettanomyces, lactic acid bacteria, etc.
- Sulfur compounds: SO2, H2S, Mercaptan, etc.
- Oxidation: oxidation, VA, acetaldehyde

Corkiness: 2,4,6-trichloranisole

- One of the most common wine faults
- Definition: a chemical compound (haloanisole) created from the interaction between microbial metabolites (mold) and chlorine
- Origin: created during cork bark harvest, storage, and production
- Smells like: wet, moldy cardboard, old books and magazines, wet concrete floor
- Human threshold for detecting TCA is thought to be as low as six parts per trillion
Natural Cork

• From the bark of the Quercus suber tree
• Is permeable and comprised of a “honeycomb” of millions of cells that are “suberinized” or individually sealed and insulated
• Can be compressed and resist moisture for decades while maintaining a seal
• Billions of natural cork stoppers are produced every year
• Achilles heel: the mold responsible for TCA is endemic to cork bark

TCA and Raw Cork Bark

• Over 90% of all TCA cork taint occurs before the raw cork bark gets to the processing plant
• After harvest raw cork bark is stacked & cured outside for up to six months—on the ground in some cases—before transport to the processing plants
• After shipping to processing plants the raw cork bark placed on pallets
• Historically the pallets constructed from wood—a potential source for TCA
• Move to stainless steel pallets vs. wood

Cork Production & TCA

• Raw cork bark sorted for quality
• Inspectors look for “yellow stain,” a mold that is a precursor to TCA
• Cork given multiple baths in boiling water
• New practices:
  • Volatiles continually removed during each bath
  • Cork bark planks separated and not stacked
  • Corks no longer bleached with chlorine substances
Raw cork bark with yellow stain - precursor to TCA
Cork Production & TCA

- Lesser quality cork bark ground to become conglomerate stoppers
- Higher quality bark is used for cork stoppers
- Cork stoppers punched by hand!
- Samples from batches of young corks undergo gas chromatography to check for TCA

Removing TCA

- TCA can be removed from granulated cork:
  - Sabaté: Diamante - use of supercritical CO2
  - Amorim: ROSA - combination of steam and high pressure
- No process exists for removing TCA from cork stoppers at this point
- TCA can be removed from wine through various kinds of filtration
- TCA can be removed from the winery by use of chlorine-free cleansing agents (ozone often used)

TCA: Other Potential Sources

- Faulty corks are not the only source of TCA
  - Contaminated machinery or bottling equipment in the winery or other facility
  - Use of chlorine substances in the winery or bottling facility
  - Airborne molds in the winery or other facility
  - Mold in transport containers
  - Mold in the home cellar
  - TCA can also be found in bottled water, screw cap beverages, beer, spirits, soft drinks, packaged food products, and even raisins.
- TCA in the environment: carpeting, gardens, leather goods, etc.
Other Thoughts on TCA

• Has the incidence of TCA in wine increased over the last few decades?
• Complexity of the cork supply chain
  • Cork producers: large vs. small
  • Cork suppliers and use of gas chromatography
• Cost of high quality corks vs. percentage of consumer complaints
• Best practices using corks by wineries
• Is the onus for getting TCA-free corks on the individual winery?
• TCA is not the only source of mustiness in wine: other haloanisoles including TBA, oxidation, sulfur compounds etc.

TCA and Non-Cork Closures

• Conglomerate corks
• Screwcaps
• Plastic corks
• Vinolok
• Closures and oxygen ingress (2005 study by Dr. Paolo Lopes of the University of Bordeaux)

Other Environmental Faults: Maderization

• Wine being exposed to excessive heat over duration of time
• One of the most common wine faults due to poor storage conditions
• Wine thermally expands inside the bottle pushing the cork up and even out
• Maderized wine smells and tastes cooked or burned
• Oxidation also common with maderized wines
Other Environmental Faults: Lightstrike

- Wines with excessive exposure to ultraviolet light
- Thought to be cause by the interaction between sulfur compounds such as dimethyl sulfide and ultraviolet light
  - More prevalent in white wines; red wines protected by phenolic compounds
  - Delicate wines such as Champagne and wines bottled in clear glass especially susceptible
- Smells like: wet cardboard or wet wool flavor and aroma
- Prevention: using colored glass bottles and storing wine in dark places

Microbial Faults

- Brettanomyces is a yeast: a unicellular type of fungus—not bacterial!
- First identified in beer production in the early 1900's; in wine in the 1950's
- Dekkora (spore-producing) often interchangeably used; both from the same genus
- Currently five recognized species of Brettanomyces/Dekkora: B. nanus, B. bruxellensis, B. anomalous, B. custersianus, & and B. naardensis
- B. bruxellensis is the most common found in wine
Yeast Types and Fermentation: How Brett Develops

- Initially yeasts best suited to high sugar concentration in the must dominate
- As sugar levels drop and alcohol levels rise *Saccharomyces cerevisiae* takes over
- As alcoholic fermentation finishes population of *Saccharomyces cerevisiae* diminishes
- If trace amounts of sugar remain after fermentation the wine can be unstable and spoilage can occur
- *Brettanomyces* one of the most common spoilage "bugs"

Causes

- Needed: the presence of residual sugar and nitrogen in wine after fermentation
- As little as 0.5 g/l residual sugar required for Brett to grow to perceptible levels
- Increasing incidence of RS in finished wine over the last 25 years with gradual rise in alcohol levels
- Brett in the winery environment: use of old barrels, containers, and winery equipment

Sensory Experience of Brett

- Three molecules dominate the sensory experience of Brett:
  - 4-ethylphenol (4EP): Band-Aids, barnyard, horse stable, antiseptic
  - Isovaleric acid (IVA): sweaty, cheesy, rancid
  - 4-ethylguaiacol (4EG): bacon, spice, cloves, smoky
- Sensitivity to these three molecules varies widely
- Brett removal: by cross-flow filtration, sterile filtration, or reverse osmosis
Brett Incidence

- Common now even in New World countries
- Increase worldwide even though winery hygiene standards have improved dramatically

Reasons:
- Natural wine trend
- Move towards an extracted international winemaking style made from super-ripe grapes
- The higher the pH the less effective SO2 and the higher the incidence of Brett
- Occurs in white wine although predominantly a red wine issue
- Why? Because red wines generally have a higher polyphenol content and higher pH

Pandora’s Box

- “One man’s flaw is another man’s complexity...”
- Profound earthiness vs. repulsive barnyard stench
- Zero tolerance vs. critical acclaim
- Recent experience with two great 1995 wines: Montebello vs. Ch. Margaux
- Studies have shown that professional taster’s ability to detect Brett and actual analyzed levels of Brett infrequently correlate

Can Brett be Managed?

- Brett as a traditional aromatic component in many historic Old World wines and regions
  - Traditional Bordeaux & Rhône wines
  - How much Brett is a good thing?
- Integrated Brett Management
  - From Clark Smith’s “Postmodern Winemaking”
  - Good structure—lower pH—maintenance of free SO2
Other Environmental Faults: Lactic Acid Bacteria

- Role of lactic acid bacteria in ML—converting malic to lactic acid
- Post ML can metabolize other compounds and produce faults
- Non-ML wines exposed to lactic acid bacteria may referment in the bottle
- Smells like: swampy, sauerkraut, slightly spritzy
- Prevention: sterile filtering wine before bottling

Other Environmental Faults: Geranium Taint

- Wine with aromas and flavors of geranium leaves
- Caused by the 2-ethoxyhexa-3,5-diene compound
- Formed during metabolism of potassium sorbate by lactic acid bacteria
- Potassium sorbate sometimes added to wine as a preservative
- Removal: sterile filtration, cross-flow filtration

Sulfur Compounds
**SO2: Sulfur Dioxide - Background**

- Much-discussed topic but rarely understood outside of winemakers
- Sulfur used for over two thousand years as an anti-oxidant in beverages and foods
- Significant antioxidant and antimicrobial properties
- If not enough SO2 is used potential for oxidation and off-flavors and aromas from microbial issues

**SO2 Regarded as a Flaw**

- When too much SO2 is used—especially during bottling
- Smells like: lit wooden matchstick, burnt rubber or mothballs
- Treatment: racking or filtration

**Use of SO2 During Winemaking**

- Used several points throughout the winemaking process
  - During crush
  - At the end of ML or at the end of primary fermentation if ML is discouraged
  - At bottling
- Best practice: use fewer but larger additions
- Most quality wines contain less than 150 parts per million
- Natural/sulfur-free wine movement
SO2 and pH Basics

• What is pH? The measure of how acidic or alkaline a solution is
• Technically relates to the concentration of hydrogen ions in the solution
• A pH of 7 is neutral:
  • Below 7 the wine is more acidic
  • Above 7 and the wine is less acidic
• pH is important for two reasons in respect to the use of SO2:
  • At higher pH levels more total SO2 is needed to get to the same level of free SO2
  • SO2 works better at lower pH levels

Sulfur Compounds: Reduction in Wine

• Reduction: often used term by professionals – but rarely understood
• Complex issue involving chemistry
• Redox reactions: reduction vs. oxidation
  • Oxidation: the loss of electrons by a chemical species
  • Reduction: the gain of electrons by a chemical species
• Chemical species defined: atoms, molecules, molecular fragments, ions, etc., subjected to a chemical process or to a measurement.

More on Redox Reactions

• Redox reactions describe the principles and behavior of most wine reactions both before and after bottling.
• A series of interlinked reactions involving oxidation and reduction of various chemical species in wine.
• Most wine chemistry is determined by this process.
• Oxidation is the loss of electrons by one species and reduction is the gain of electrons.
• “Redox Potential”: measuring the potential of a species to gain and give up electrons.
• Redox potential measured in millivolts (mV) – optimum vs. non-optimum ranges in wine
Winemaking and Reduction

- Modern winemaking = reductive winemaking
- Use of closed stainless steel tanks, cultured yeasts; anaerobic fermentation, aging, and bottling, use of SO2 as an antioxidant
- Result - upside: clean, fruit-driven style

Reductive Winemaking & Volatile Sulfur Compounds

- Downside of reductive winemaking: potential for forming volatile sulfur compounds
- Result is what is often described as "reduced" by tasters
- Sulfur flavors in wine: burnt matchstick, garlic, onion, rotten eggs
- These compounds can still exist in oxidative conditions hence frequent confusion (sulfides exist in wine regardless of oxidized vs. reduced state)
- Chemical analysis vs. sensory thresholds

Hydrogen Sulfide: H2S

- Most intense smelling sulfur compound
- Origin: formed during fermentation by nutrient deficient must
- Smells like: sewer gas or rotten eggs
- Cause: when yeast draws on sulfur compounds for a nitrogen source H2S is released
- Can also be caused by sudden temperature change in the must
- Remedy: addition of diammonium phosphate (DAP) to must as a potential nitrogen source or use of copper sulphate to clean up the must or wine
Mercaptan
- H2S can further react with wine compounds to form mercaptans and other disulfides
- Mercaptan: a group of larger sulfur containing molecules
- Smells like: natural gas, onions or garlic
- Origin: formed when H2S is not removed quickly from the must
  - Can also be formed in finished wine is allowed prolonged contact with the lees
- Preventive measures: removing H2S quickly from must using DAP or copper sulphate & racking wine off lees

Other Sulfur Compounds: Dimethyl sulfide (DMS)
- Naturally present in most wines
- From the breakdown of sulfur containing amino acids
- Below sensory threshold (>30 µg/L) contributes to fruitiness & complexity
- Above threshold smells like canned corn, cooked cabbage, asparagus, vegetal
- Treatment: prevent H2S from forming during fermentation; sterile filtration or use of copper sulphate in the finished wine

Managing Volatile Sulfur Compounds
- Yeasts responsible for 99% of all volatile sulfur flavors
  - Sulfur compounds formed by yeasts during fermentation and after they die
- Prevention largely based on choosing the specific yeast strain and yeast nutrition during fermentation (specifically the nitrogen source)
  - Higher sugar in the must =
    - Lower natural content of nitrogen compounds
    - Higher yeast stress
    - Higher risk of volatile sulfur compounds
Managing Volatile Sulfur Compounds Cont.

- Oxygen addition during fermentation
  - Use of micro-oxygenation for high pH musts
- Yeast management during aging: dead yeast cells (light lees) must be stirred regularly to avoid reductive "zones" in the barrel or tank
- Use of Bâtonnage also adds small amounts of oxygen to the wine

Oxidation Faults

Oxidation

- Arguably the most common of all wine faults
- Can occur throughout the winemaking process and even after the wine has been bottled
- Anthocyanins, catechins, and other phenols in wine are the most easily oxidized
- Leads to loss of color, aromatics, and flavor
- Smells like: lack of fruit, dried or cooked fruit, dull, flat
Oxidation Faults: Acetaldehyde

- A byproduct of fermentation commonly associated with oxidation of ethanol
- Also occurs with the presence of surface film forming yeasts and bacteria on wine in tank or barrel
- Smells like: Sherry, roasted nuts or dried out straw
- Treatment: adding SO2 to the wine; acetaldehyde binds to sulfur and produces an odorless/tasteless compound

Oxidation Faults: Volatile Acidity - Acetic acid

- By-product of fermentation or due to spoilage of finished wine
- Created by many different wine spoilage yeasts and bacteria
- Smells like: vinegar
- Sensory threshold for acetic acid in wine is >700 mg/L
- Treatment: sterile filtration, cross-flow filtration, reverse osmosis

Oxidation Faults: Volatile Acidity - Ethyl acetate

- Common microbial fault produced by wine spoilage yeasts
- Formed by the chemical reaction of ethanol and acetic acid
- Wines with high acetic acid levels are more likely develop ethyl acetate formation
- High levels of ethyl acetate are also produced by lactic acid bacteria and acetic acid bacteria
- Smells like: nail polish remover, glue or varnish
- Treatment: sterile filtration, cross-flow filtration, reverse osmosis
Resources for Learning More About Wine Flaws

• www.guildsomm.com
• Using Le Nez du Vin Les défauts