NORTH CAROLINA SENSORY EVALUATION WORKSHOP

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THANK YOU!

- North Carolina Sensory Analysis Workshop
- Surry Community College
- Dr. Rick Donley – Director, ASU Enology & Viticulture Program
- Molly Kelly, Dr. Seth Cohen and Dr. Trevor Phister for presentations of wine faults
- Workshop Organizing Committee
GO BUCKEYES!
WE LOVE THIS STATE!!!
OUTLINE

• Introduction to sensory Evaluation
• Sensory evaluation in the winery
  • Commercial Applications
  • Setting up a sensory lab
  • Sensory evaluation tests
• Critical aspects in preventing wine flaws
  • Oxygen and headspace
  • The use of SO₂
  • Fruit Quality – Microbial concerns
  • Sterile bottling Issues including sorbate and DMDC
SENSORY EVALUATION

- Sensory evaluation is a scientific discipline used to evoke, measure, analyze and interpret reactions to stimuli from wine using our five senses.
- It is important in the grape and wine industry since there is no instrumentation or analytical method that can reliably assess:
  - Wine flavor
  - Wine quality
  - Consumer preference
SENSORY EVALUATION

- Important for the commercial wine industry from harvest to bottling
  - Evaluation of juice samples for maturity and off aromas
  - Evaluating the fermentation process
  - Post fermentation during
    - Wine aging
    - Fining trials
    - Blending trials
    - Post bottle storage and aging quality
SENSES USED IN TASTING WINE

- **Sight**: Used in determining a wine’s appearance of color and clarity.
- **Smell**: Used in identifying wine aroma and bouquet (very complex).
- **Taste**: Used in determining sweetness, sourness, bitterness and saltiness in addition to helping perceive balance (sugar/acid ratio).
- **Touch**: temperature, pain, tactile sensations of astringency (tannin), viscosity (sugar & alcohol).
SENSES USED IN TASTING WINE

• Of the senses used in tasting wine, smell is arguably the most important attribute

• Retro-nasally
  • Wine warms up in the mouth and releases further aromatic compounds/molecules which reach the olfactory region by diffusion and through exhalation

• Specialists express “flavor” as utilizing the sense of smell and taste of wine component’s together
SENSE OF AROMA

Diagram showing the medial olfactory area, olfactory tract, olfactory bulb, olfactory glomerulus, nerve fibers, olfactory sensory cell, cilia, olfactory epithelium, and mucus layer. Table showing the total area of olfactory epithelium, number of sensory cells, life of sensory cell, lowest concentrations detectable, number of odors distinguished, and decline with age.
Sense of Taste

• Sweet taste is provided by alcohol and sugars
• Sour taste comes from free organic acids
• Bitter comes from wine phenolics (mainly tannin)
• Salty not as pronounced in sensory evaluation of wines but can be present (Cations: K, Na, Ca, Mg and Anions: phosphate, sulfate, tartrate, malate and lactate along with excess lactate along with excess fermentation nutrients
SENSORY EVALUATION

• Many wines exhibit an interrelation of the senses when performing sensory evaluation of wine descriptors
  • A cloudy wine will most likely have a less pleasant, less distinctive or off aroma
  • An recent vintage white wine with brown hues may have an oxidized aroma
  • A wine with distinct varietal aroma is less likely to express taste deficiencies on the palate
PERFORMING SENSORY EVALUATION

• When performing sensory evaluation, evaluate the following sensory descriptors often utilized in most national and international wine competitions:

• Appearance:
  • Color and Clarity
  • Color: Should be representative of variety, vintage, style and blend composition
  • Clarity: Should be free of any amorphous haze or deposit and brilliant in color
PERFORMING SENSORY EVALUATION

- Aroma and Bouquet:
  - The aroma is derived from the grape itself (varietal character)
  - The Bouquet is derived from the cellar through fermentation, processing, or aging
  - The winemaker’s desire should be to perfect an unmistakable characteristic aroma of the grape variety or wine type in addition to an outstanding and complex bouquet
PERFORMING SENSORY EVALUATION

• Taste:
  • Flavors should carry nicely from the aroma onto the palate
  • The wine should be balanced in regards to the fruit present, sugar/acid ratio, tannin, alcohol and other processing attributes such as oak and lees perception
    • These all add up to form the body/mouthfeel of the wine
  • The key to a balanced wine is that one of these attributes should not mask another excessively
PERFORMING SENSORY EVALUATION

• Aftertaste:
  • All of the aromas, flavors and tactile sensations of the wine should be balanced in a way to provide a pleasing, lingering aftertaste or finish

• Overall Impression:
  • Taking all sensory descriptors being evaluated in mind, what is the overall impression of the wine being evaluated
SENSORY EVALUATION

- In light of this, it is vital to become familiar with varietal characteristics, wine styles and **wine flaws**
- This can be accomplished through increased tasting of all wines on a personal basis
  - Taste, Taste, Taste
  - Avoid varietal racism
  - Avoid cellar palate
- Participate in educational tastings including wine flaw recognition
  - Kits are also available in both varietal characteristics and wine flaws
SENSORY EVALUATION

• It is advisable to become familiar with sensory descriptors to help aid the process
  • The Wine Aroma Wheel provides an excellent tool for this process
  • Develop standards for training winery personnel on these descriptors

• When working with wine flaws, it is important to use a control base wine when comparing the flaw in the same wine matrix
According to Paynaud (1996) “the role of tasting expertise is not the identification of anonymous wines, but the exercise of quality control. Its function is to judge whether a wine is free of fault which might lessen its value or render it unfit for consumption and to see whether it has qualities required by its denomination.”

SENSORY EVALUATION

• However, individual differences occur in picking up specific wine compounds/components relating to their thresholds in wine
• Consumer preference in addition to winery desires and goals must also be addressed
SENSORY EVALUATION: IN THE WINERY

• Research and Development
  • Introducing a new wine, Evaluating an essence or flavoring material, different oak sources

• Important for Quality Control
  • Test for off flavors, reformulation changes, quantifying effects of processing changes, blending and fining trials

• Sales & Marketing
  • Brand management, effectiveness of packaging etc.
SENSORY EVALUATION:
COMMERCIAL APPLICATION

• A number of good wine glasses
• Wine “tuits” or sharpie
• Graduated cylinder’s (100ml, 50ml, 25ml and 10ml)
  • For blending purposes in making a good wine great
• Graduated pipette (10ml)
• Several beakers - sample collection (250ml)
• Take a representative (homogenous) sample from each tank or barrel involved
SENSORY EVALUATION: COMMERCIAL APPLICATION

- Label tanks and barrels correctly on sample beakers and tasting sheet
- Use 200 mls of clarified wine for fining trials and use a control sample with no treatment (difference test)
- Use 100 mls in blending for easy calculations
- Laboratory scales (0.1g) – for sugar additions
SENSORY EVALUATION: COMMERCIAL APPLICATION

• Pencil, tasting notes and sheet
  • Write lots of detailed descriptive notes

• Laboratory markers

• In the case of trying to improve a slight wine flaw by blending, it is best to perform any fining trials required on the wine prior to performing any blending trials involving good wine
SENSORY EVALUATION: COMMERCIAL APPLICATION

- Tasting notes should include:
  - Appearance, Aroma, Taste, Aftertaste and Overall impression
- Tastings should all be performed blind
- Integrate other trusted (professional) palates into the sensory evaluation process
<table>
<thead>
<tr>
<th>Flight</th>
<th>Code</th>
<th>Score</th>
<th>Wine</th>
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<tr>
<td>Glass</td>
<td>Wine/Treatment/Tank</td>
<td>Lab Results</td>
<td>Notes</td>
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SENSORY EVALUATION: COMMERCIAL APPLICATION

• May also include a target benchmark variety for comparison
  • Consist of Gold Medal or top Wine Spectator Rating
• Evaluate each variety, lot or tank in a sincere, concentrated focus on proper sensory evaluation
  • Designate a sensory evaluation area that is free from distractions and smells with good lighting
CHEMICAL ANALYSIS

- Many times chemical analysis will back up sensory results
- Help to isolate or troubleshoot problem areas for both fining and blending treatments
SENSORY EVALUATION TESTS IN THE COMMERCIAL WINERY

- Descriptive analysis
- Difference/Discrimination tests
- Intensity rating
- Hedonic tests
- Paired preference
DESCRIPTIVE ANALYSIS

- The goal is to identify the aroma and flavor profile of a wine
- Takes most time in development of panel and training on descriptors
- Using panel discussion decide upon flavor/aroma characters of wine
- Train tasters using standards (wine spiked with desired attribute)
- Blind tasting to determine if characters can be reproducibly recognized in wines
DIFFERENCE/DISCRIMINATION TEST

• Used to determine whether a difference exists between samples
• Require trained or experienced evaluators
• Can be most beneficial for commercial wineries
• Require statistics for validation
• Principle tests used:
  • Triangle, Duo-trio, Paired comparison
TRIANGLE TEST

- Judges are provided with three random coded samples
- Two are the same, and one is different
- They are asked to identify the odd sample
- Results are based on the probability of the odd sample being chosen \( \frac{1}{3} \) of the time
- Tasting order needs to be randomized & repeated
  - AAB, BAA, ABA, ABB, BAB
- Require statistical evaluation for validation
DUO-TRIO TEST

- Involves comparison of two wines with a reference wine being provided
- The reference sample is provided first
- Evaluators are asked to identify the sample being the same as the reference wine
- No attribute is indicated and can be based on individuals sensory judgment
- Results based on probability of evaluator being able to pick the correct sample 50% of the time
- Require statistical analysis for validation
PAIRED COMPARISON

- Judges are evaluating a specific attribute
- The panelists are given two wine samples and asked to identify the sample with the highest concentration of the attribute in question
  - i.e., astringency, oak, sweetness, alcohol etc...
- Results based on the probability of the evaluator being correct 50% of the time
- Require statistical analysis for validation
INTENSITY RATINGS

• Involves extensive training of judges on specific attributes

• Training involves recognition of differing concentrations of acidity or Brett for example

• The intensity is converted to a numerical scale typically from 1 to 10

• Requires more detailed statistical analysis for this test making it less attractive for commercial application
HEDONIC TESTS

- Can utilize untrained personnel or evaluators
- Identifies whether a taster likes or dislikes a particular wine
- Most commonly used scale in the food industry
- Can assess 2 or more samples
- 9 point scale most common practice
- Can use an in-house scale evaluation as well
## HEDONIC SCALE EXAMPLES

<table>
<thead>
<tr>
<th>9 Point Common Scale</th>
<th>Overall (In-house) Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Like Extremely</td>
<td>1. Excellent, I’ll buy a case</td>
</tr>
<tr>
<td>2. Like Very Much</td>
<td>2. Shure, I’ll buy a bottle</td>
</tr>
<tr>
<td>3. Like Moderately</td>
<td>3. Hey, I’ll take a glass</td>
</tr>
<tr>
<td>4. Like Slightly</td>
<td>4. It’s alright</td>
</tr>
<tr>
<td>5. Neither Like or Dislike</td>
<td>5. There is nothing else available</td>
</tr>
<tr>
<td>6. Dislike Slightly</td>
<td>6. I’ve had better</td>
</tr>
<tr>
<td>7. Dislike Moderately</td>
<td>7. There are some issues here</td>
</tr>
<tr>
<td>8. Dislike Very Much</td>
<td>8. Is this wine</td>
</tr>
</tbody>
</table>
HEDONIC TESTS

• Since this is a popular test for consumer preference, make sure there is no pre-bias from the person organizing the evaluation.

• Make sure there is a representative population for this test.

• Be careful for any bias developed from an attractive phrase describing the wine if you choose to make your own scale descriptors.
INTERPRETING THE RESULTS

• Nice Statistical tool from The Australian Wine Research Institute (AWRI) to help determine significance in your sensory evaluation tests found at the following site:

• Further sensory evaluation information regarding sensory tests, procedures and statistical results:
FURTHER RECOMMENDATIONS

• Be careful not to have too many samples (depending on test) causing palate fatigue
  • 5 to 10 samples at a time unless there are greater differences between samples
    • Several flights or repetitions of 5 to 10 samples can be evaluated successfully in a period of several hours
  • If simply eliminating poor or off samples, more can be evaluated

• Keep everything the same in respect to serving vessels, size, glassware, temperature and three digit random codes (No variables which may cause a bias)
FURTHER RECOMMENDATIONS

• Provide enough (minimal) information regarding test and be neutral as possible
• If looking at aroma and/or taste differences alone,
  • May be beneficial to use colored glasses (cobalt) to avoid bias from color
• Provide motivation for tasting
  • Judges become more efficient and reliable
    • Provide reports of their results
    • Assure them they are participating in something important
    • Either pay them or provide other award for their services
THE IDEAL SENSORY LABORATORY
THE IDEAL SENSORY LABORATORY

- Centrally located for winery staff and consumers
- The sensory lab should be separated from the wine lab to reduce chemical smells that will interfere with the sensory evaluation
- Separated from other areas producing odoriferous smells such as: fermentation, bottling, restaurant etc.
- Good ventilation system
THE IDEAL SENSORY LABORATORY

- White in color with natural or incandescent lighting
- Fairly soundproof to avoid distractions
  - Avoid music and conversation between judges
- Temperature control from 60 to 63°F
- Large conference area for discussion and group tastings
THE IDEAL SENSORY LABORATORY

- Separate wine preparation area away from judges access
- Separate booths (permanent or temporary) with serving port or separate tables for individual judges
- However it is designed, make sure a professional environment is created for importance of judging sincerity and efficiency
BUDGET COMPROMISED SENSORY LAB

- Quiet, enclosed environment
- Good lighting with white background to evaluate appearance (color and clarity) properly
- Away from potential sources of aromas that may effect sensory perception
- Have someone in charge of setting up tasting in a blind format
BUDGET COMPROMISED SENSORY LAB

• Include enough evaluators hopefully for statistical significance or to throw chance out of the equation

• Do not attempt to evaluate too many samples at once - 5 to 10 samples repeated 3 times (morning, afternoon, evening)
CRITICAL ASPECTS IN PREVENTING WINE FLAWS

• Oxygen and Headspace
• The Use of SO₂
• Fruit Quality
LIMITING OXYGEN EXPOSURE

• Generally, oxygen is detrimental for wine quality from the end of fermentation through bottling and aging of wine
  • Due to both chemical (oxidation) and microbiological (aerobic yeast and bacteria) reasons
• Oxygen can range in wine from 6 to 9 mg/L
• Oxygen will dissolve in wine more rapidly at lower temperatures however, oxidation occurs more rapidly at warmer temperatures
LIMITING OXYGEN EXPOSURE

• Avoid potential sources for oxygen pickup
  • Wine transfer, racking, excess headspace, pumping filtration, cold stabilization and bottling

• In light of this, keep tanks full, fill tanks from bottom, inspect for leaky pump seals, secure any loose hose connections or fittings on the inlet side

• Monitor and Maintain sulfur dioxide base on wine pH to at least 0.8 ppm free SO₂
LIMITING OXYGEN EXPOSURE

- Purge transfer lines and tanks/barrels with an inert gas prior to filling
  - (nitrogen, CO₂, argon or nitrogen/CO₂ mixture)
- Keep bottling tank headspace to a minimum
- Maintain a slight but constant pressure over any headspace
  - (nitrogen, CO₂, argon or nitrogen/CO₂ mixture)
LIMITING OXYGEN EXPOSURE

- If oxygen content is too high prior to bottling, sparging wine with an inert gas like nitrogen or carbon dioxide is possible
  - Nitrogen or argon is preferred in limiting possible excess CO$_2$ from entraining into wine prior to bottling
- Recommended levels of dissolved oxygen in wine after bottling
  - Red wine $\leq 1.25$ mg/L
  - White, Blush & Rose wine $\leq 0.60$
OXYGEN ELIMINATION AT BOTTLING

- Wine Transfer
- Filtration
- Filler bowl
- Filling Process
- Bottle Headspace
- Closure
THE USE OF SULFUR DIOXIDE IN PREVENTING BOTH CHEMICAL AND MICROBIAL INSTABILITY
IMPORTANCE OF SULFUR DIOXIDE

• As an antioxidant
  • Protects musts and wines from browning
  • Binding of acetaldehyde

• Antiseptic activity
  • Prevents microbiological spoilage in wines from microorganisms such as acetic acid bacteria, lactic acid bacteria, molds, and wild yeast

• At certain levels SO$_2$ may promote a rapid and complete clarification of must and wine
DISADVANTAGES OF SULFUR DIOXIDE

- Sensory
  - Excessive amounts can cause a metallic and harsh character to wines
  - High levels of free sulfur dioxide add a pungent aroma or sharpness in the nose
- Color
  - Bleaching of color from red varieties
DISADVANTAGES OF SULFUR DIOXIDE

• Incomplete fermentation's
• Cold instability with higher amounts used
• Certain species of wild yeast such as *Zygosaccharomyces* can tolerate high levels of free SO$_2$
FORMS OF SULFUR DIOXIDE

- “Free”
  - Includes (molecular, bisulfite and sulfite) forms not chemically bound to other wine constituents
- “Bound”
  - Sulfur dioxide forms that combine with other wine constituents
- “Total”
  - Refers to the amount of free plus bound SO$_2$
ESSENTIAL TIMES FOR SO$_2$ ADDITION

- Crushed grapes or must
  - Amount based on condition of grapes, temperature and pH
- Immediately after alcoholic fermentation
  - Amount based upon wine style and variety
- Wine storage
  - Treat wines at regular intervals with additional amounts to prevent oxidation and spoilage
- Pre-bottling
  - Adjust to 0.8 ppm molecular based on wine pH
FORMULA TO CALCULATE SO₂
ADDITION TO CRUSHED GRAPES

Wt. Of K₂S₂O₅ = Y x Z x 1.72

Where: Y = weight of crushed grapes (9.0 lbs. per gal.)
Z = multiplication factor of desired ppm SO₂
1.72 = conversion factor to change SO₂ to K₂S₂O₅
FORMULA TO CALCULATE SO$_2$
ADDITION TO WINE

Wt of K$_2$S$_2$O$_5$ = \( \frac{Y \times 3.8 \times 1.72 \times Z}{1000} \)

Where:
- \( Y \) = volume of wine in gallons
- \( 3.8 \) = conversion factor to change gallons to liters
- \( 1.72 \) = conversion factor to change SO$_2$ to K$_2$S$_2$O$_5$
- \( Z \) = desired ppm SO$_2$
- \( 1000 \) = conversion of mg/L to gm/L
**ADDICTION OF SO$_2$ PRIOR TO BOTTLING TO OBTAIN .8 PPM (MOLECULAR)**

<table>
<thead>
<tr>
<th>pH</th>
<th>Free SO$_2$</th>
<th>pH</th>
<th>Free SO$_2$</th>
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<tr>
<td>2.9</td>
<td>11</td>
<td>3.5</td>
<td>40</td>
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<td>3.0</td>
<td>13</td>
<td>3.6</td>
<td>50</td>
</tr>
<tr>
<td>3.1</td>
<td>16</td>
<td>3.7</td>
<td>63</td>
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<tr>
<td>3.2</td>
<td>21</td>
<td>3.8</td>
<td>79</td>
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<tr>
<td>3.3</td>
<td>26</td>
<td>3.9</td>
<td>99</td>
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<tr>
<td>3.4</td>
<td>32</td>
<td>4.0</td>
<td>125</td>
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Source: C. Smith, Enology Briefs. Feb/March, 1982, Univ. of Calif., Davis
ADJUSTING SO\textsubscript{2} AT BOTTLING

- In addition to adding SO\textsubscript{2} at a rate of .8 mg/L based on wine pH prior to bottling, should also adjust SO\textsubscript{2} levels to account for oxygen pickup during bottling
  - 4 mg/L of SO\textsubscript{2} will react with 1 mg/L of oxygen
  - If we assume 1 to 2 mg/L oxygen pickup at bottling we would need an additional 4 – 8 mg/L SO\textsubscript{2} prior to bottling
ADJUSTING SO₂ AT BOTTLING

• Length of bottle aging, variety and vintage
  • White wines meant for consumption at 6 months may not need additional SO₂ then described above
  • However, wines meant for longer aging periods may require an additional 10 to 15 mg/L SO₂ added
FRUIT QUALITY AND MICROBIOLOGY CONCERNS
FRUIT CONDITION - ROT

• “You can’t make a silk purse out of a sows ear!”
FRUIT CONDITION - ROT

- Produces enzymes called tyrosinase and laccase which causes browning and oxidation.
- Increases levels of glucan which make wine hard to filter.
- Damage fruit leads to secondary spoilage by microorganisms producing off odors and flavors.
FRUIT CONDITION - ROT

• Acetic and lactic acid bacteria can be problematic in rot scenarios
  • May play important roles in the production of off aromas and flavors before, during and after fermentation

• Native yeast originating in the vineyard
  • Hanseniaspora and Kloeckera can produce high levels of ethyl acetate during pre-fermentation processing mainly during cold soak and/or low-temperature fermentation
FRUIT CONDITION - ROT

- With an increase in fruit deterioration, species diversity and population densities of native yeast increase in the vineyard
  - Hansenula, Candida and Pichia
- Collectively, these may have a significant sensory impact
- Physiological damage by birds and bees can also lead to microbiology concerns
WINERY MICROBIOLOGY

- Winery derived yeast:
  - *Brettanomyces, Zygosacccharomyces* and various strains of *Saccharomyces*
  - Capable of rapid growth under proper conditions
WINERY MICROBIOLOGY

- Winery derived bacteria:
  - Lactic Acid Bacteria such as *Lactobacillus kunkeii*, *Oenococcus* and *Pediococcus*
  - Acetic acid bacteria
- Capable of producing problems in both primary and secondary fermentations in addition to other off by-products in both aroma and taste
FRUIT CONDITION – ROT AND WINERY MICROBIOLOGY CONCERNS

• Increased microbial properties can lead to a depletion of nitrogen (YANC) needed for a successful primary fermentation.

• An increase in rot elevates must pH (> 3.5):
  • Greater chance for both chemical and microbial instabilities.
  • Also, tartrate, protein, color and SO₂ effectiveness.
Spoilage products produced by microorganisms from rot

- **Yeast**: hydrogen sulfide, acetic acid, ethyl acetate, higher alcohols, etc..
- **Molds**: glycerol, gluconic acid, ethanol, etc..
- **Bacteria**: acetic acid, lactic acid ethyl acetate, butyric acid, acetaldehyde, hydrogen sulfide, etc..
### EFFECT OF GRAPE CLUSTER ROT ON WINE QUALITY

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<th>% Rot</th>
<th>pH</th>
<th>% TA</th>
<th>Sensory Score</th>
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<td>0</td>
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<td>.56</td>
<td>13.9</td>
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<td>5</td>
<td>3.79</td>
<td>.49</td>
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<tr>
<td>40</td>
<td>3.74</td>
<td>.61</td>
<td>6.1</td>
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Loinger (1977)
Since bottling is the last winemaking process, it is essential that all bottling operations including filtration be properly sanitized.

The most efficient sterilization process is the use of steam or hot water at ≥ 180° F.

Although effective, chemical sterilization from chlorine based compounds, iodophors, sulfur dioxide/citric acid and ozone have limitations with Clean in place (CIP) operations.

Due to the inability of water based compounds penetrating the submicron cracks of the bottling line.
STERILE BOTTLING

• Purpose is to remove all wine tolerant microbes in that they do not present a post bottling threat or concern to the finished product

• Proper sterilization of the bottling line and filter unit is essential

• Filtration is critical to successful sterile bottling
  • 0.45 micron absolute membrane cartridge filter (bacteria and yeast)
  • 0.60 to 0.80 micron absolute membrane cartridge filter (yeast) not a guarantee for daughter cells

• Essential to perform bubble point test
BOTTLING LINE STERILIZATION

- It is good to develop a quality control plan at the bottling line for your sterilization procedure
  - Take swab and air samples of the bottling line and room
  - Collect wine samples during bottling at regular intervals (i.e., beginning, middle and end) for microbial analysis and plating
CHEMICAL PRESERVATIVES AND STERILANTS

• The use of chemical preservatives and sterilants should not be used as a substitute for sterile bottling but may be used in addition to sterile bottling if desirable and needed
Therefore, if one is not completely sure of their sterile bottling techniques and procedures, the use of chemicals such as sorbic acid and dimethyl dicarbonate (DMDC) (Velcorin ®) may be used to help you sleep at night!
IMPORTANCE OF SORBIC ACID

• As a chemical preservative
  • sorbic acid is used to protect against yeast and mold growth and spoilage generally in wines that contain some residual sugar
DISADVANTAGES OF SORBIC ACID

• Sensory
  • Certain people can detect sorbic acid levels normally found in wines
  • Sensory threshold reported at 135 mg/L
  • Malolactic bacteria may convert sorbic acid to an undesirable odor (Geranium)
    • Use in conjunction with proper amount of SO₂
• Not much activity against *Zygosaccharomyces*, *Brettanomyces* and *Dekkera*
SOURCES OF SORBIC ACID

- Potassium sorbate
  - Salts of sorbic acid are used due to their greater solubility in water
  - Higher amounts used may cause concern for cold instability
FORMS OF SORBIC ACID

• Sorbic acid behaves like sulfur dioxide in that the undissociated molecule is the most effective form in preventing yeast growth.

• Therefore as pH decreases, the greater the percent of undissociated acid.

• The greater microbial load present, the more sorbic acid required to be efficient.
ESSENTIAL TIMES FOR SORBIC ACID ADDITION

- In general, sorbic acid is added prior to bottling to prevent further fermentations and off flavors.
- A general range of 150 - 200 mg/L of sorbic acid is usually used at time of bottling.
- Legal limit is 300 mg/L
FORMULA TO CALCULATE POTASSIUM SORBATE ADDITION TO WINE

Wt. Of potassium sorbate = \( \frac{Y \times 3.8 \times 1.34 \times Z}{1000} \)

Where:
- \( Y \) = volume of wine in gallons
- \( 3.8 \) = conversion factor to change gallons to liters (L/gal.)
- \( 1.34 \) = conversion factor to change sorbic acid to K-sorbate
- \( Z \) = desired ppm (mg/L) of SO₂ to be added
- \( 1000 \) = convert mg/L to gm/L
DMDC: IMPORTANCE

• Dimethyl dicarbonate (DMDC) is a very effective yeast sterilant and has replaced sorbic acid in many wineries

• Sold under the trade name Velcorin®

• Lethal towards yeast and most lactic acid bacteria at maximum level of 200 mg/L (Fugelsang, 1997)
DMDC ADDITION

- Larger wineries atomize it into the bottling line using a proportional pump.
- Smaller sized wineries will dissolve the appropriate amount of DMDC to be used in a small portion of absolute ethanol then add it directly back into the wine to be bottled.
DMDC: LIMITATIONS

- Although effective against most spoilage yeast, its killing properties is less effective on bacteria normally found in wine (Boulton et al., 1999)

- DMDC is hydrolyzed rapidly with no residual activity, secondary contamination can be a problem making sterilization procedures of the bottling line critical in keeping the microbial load down in the bottled wine
DMDC: LIMITATIONS

- DMDC needs to be handled properly since it can burn the skin and pose a health threat if ingested.
- Advisable to check out the cost efficiency in using DMDC from your winery perspective.
ADDITIONAL WORKSHOP POSSIBILITIES

• A complete guide to winery sanitation
• Identification and discussion of chemical instabilities such as protein, tartrates, metals etc.
• Making good wines great through fining and blending trials
THANK YOU!

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