Post-Fermentation Finishing

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Post Fermentation Treatment Goals

- Stability
- Compositional Adjustment
- Style
- Clarity
- Packaging

Stability

- GOAL: Stabilize the clarity and desirable sensory characteristics
  - Stability: Types of Problems
    - Microbial Stability
    - Chemical Stability
    - Protein stability

Microbial Stability

- GOAL: Prevent microbial growth and/or metabolism especially in the bottle to prevent both turbidity and off-character production
  - Preventing microbial growth not only eliminates turbidity but also avoids the production of microbial off-characters
  - Spoilage Characters:
    - Bacteria (Lactic Acid, Acetic Acid, Bacillus)
    - Yeast
    - Molds

Lactic Acid Bacteria

- Off-character production
  - Mousiness – mouse urine/mouse nest
- Turbidity
- Effervescence (CO_2)
- Prevention: SO_2

Acetic Acid Bacteria

- *Acetobacter aceti* – organism responsible for the conversion of wine into vinegar
- Requires Oxygen
- Acetic acid accompanied by ethyl acetate
  - Ethyl acetate – reminiscent of nail polish remover

Prevention of Acetic Acid Bacteria

- Use of SO_2 – frequent monitoring of SO_2
- Use of inert gases in headspaces in tanks
- Topping off to prevent oxygen exposure
  - Oxygen stimulates the growth of the organisms on the surface of the wine

Spoilage Yeasts

- Zygosaccharomyces
- Pichia
- Candida
- Brettanomyces/Dekkera
- Saccharomyces
  - Most Yeasts can be inhibited by proper SO_2 management and/or DMDC (dimethyl dicarbonate)

Brettanomyces (BRETT)

- Produces off flavors and aromas in wines
- Complexity or character?
  - Typical barnyard aroma
- Lab Background
  - Synthesize 4-ethyl phenol (4-EP)and 4-ethyl guaiacol (4-EG)
  - 4-EP and 4-EG are determined by HPLC analysis (ETS DNA analysis)

BRETT Management

- Monitor wines monthly for Brett by plating
- Topping bbls are sampled every two weeks and monitored for Brett
- Barrel samples are from 4 bbls – each using different thief
- Brett plates are YM agar with cycloheximide solution will show Brett cells within 7-10 days

BRETT Management (2)

- Maintain SO_2 levels
- Empty barrel management
- If Brett > 100 cfu's, individual bbl plating will be done and bbls flagged as B+
- Decision for Brett contaminated wines:
  - Rack and filter to 0.5 micron; cross flow filter

Sulfur Dioxide (SO_2)

- Physical Properties
- SO_2 is a colorless, non-flammable gas
- SO_2 exists in wine in 'free' and 'bound' forms, sum of FSO_2 + bound SO_2 = Total SO_2
- Free Sulfur Dioxide has 3 forms
  - Molecular (SO_2) – prevents microbial growth
  - Bisulfite (HSO_3^-) – binds with phenolics and acetaldehyde
  - Sulfite ($SO3-_2$) – acts as an antioxidant

Molecular SO_2

- Most effective form of SO_2
- 0.8 mg/L (ppm) is needed to inhibit microbial growth activity

Molecular SO_2 as function of pH

pH	FSO_2 for 0.825 mg/L
3.0	14.8
3.1	18.5
3.2	23.1
3.3	28.8
3.4	36
3.5	45.1
3.6	56.5
3.7	71.1
3.8	89.3

Chemical Instabilities

- Metal Ions (Fe and Cu form precipitate)
- Tartrate (will crystallize at low temps)
- Polymerized Phenols
- Oxidation Products

Chemical Instabilities (2)

- Tartrates
  - At low temps, tartrates will crystallize
  - Mistaken for glass by consumers
  - Unstable in presence of Ca^{++}
  - Solubility depends upon pH, K^{+}, tartrate concentrations
- Tartrate: The solution
  - Super-chill wine to catalyze crystallization
  - Nucleate process with tartrate crystals

Chemical Instabilities (3)

- Polymerized Phenols
  - Can precipitate during aging (mixture of tannin and protein)
  - Undesired in bottle
- Oxidation Products
  - Off-color
    - Brown, Pink, Orange
  - Off-Characters
    - Aldehydes
  - Prevented by using antioxidants

Protein Instability

- Proteins involved are from grapes
- Denature over time causing visible haze
- Can be prevented by fining - bentonite

Compositional Adjustment

- To increase acid add:
  - Tartrate
- To decrease acid add:
  - Potassium Carbonate
- To remove volatile acidity
  - Reverse osmosis

Acid Reduction

- Potassium Carbonate
  - Useful in must and wine with moderately high acid (9 – 12 g/L as tartaric)
  - An addition of 0.62 g/L will decrease TA by approximately 1.0 g/L
  - Prone to large pH shifts (approximately 0.15 units per each 1 g/L TA drop)
  - Can be used in juice followed by ML

Analysis of Must and Wine – Chenin Blanc

(J.R. Munyon and C.W. Nagel; Am. J. Enol Vitic., Vol. 28, No. 2, 1977)

	MUST			WINE				
Treatment	**pH**	**TA (%)**	**Soluble Solids (%)**	**pH**	**TA (%)**	**Tartaric acid (%)**	**Malic acid (%)**	**Avg. Rank**[a]
None	2.92	1.19	19.40	2.93	1.02	0.36	0.56	3.63[b]
Ca double salt				3.26	0.86	0.25	0.53	3.08
$CaCO_3$				3.33	0.82	0.13	0.55	2.67
K_2CO_3				3.57	0.77	0.09	0.57	2.83

Analysis of Must and Wine – White Riesling

	MUST			WINE				
Treatment	**pH**	**TA (%)**	**Soluble Solids (%)**	**pH**	**TA (%)**	**Tartaric acid (%)**	**Malic acid (%)**	**Avg. Rank[a]**
None	2.97	1.17	20.70	2.83	1.10	0.52	0.34	3.54[b]
Ca double salt				3.10	0.82	0.28	0.30	2.83
$CaCO_3$				3.25	0.78	0.14	0.33	3.29
K_2CO_3				3.40	0.76	0.12	0.35	2.96

Analysis of Must and Wine – Zinfandel

	MUST			WINE				
Treatment	pH	TA (%)	Soluble Solids (%)	pH	TA (%)	Tartaric acid (%)	Malic acid (%)	Avg. Rank[a]
None	3.20	1.15	18.50	3.18	0.95	0.31	0.45	3.29
Ca double salt				3.37	0.82	0.20	0.41	2.50[c]
$CaCO_3$				3.51	0.72	0.08	0.44	3.58
K_2CO_3				3.68	0.67	0.09	0.44	4.58[b]
Malo-lactic				3.32	0.66	0.18	trace	3.83

Malo-lactic Fermentation

- Difficult at low pH (=< 3.0)
- Metabolism of 1 g/L malic acid results in a theoretical TA decrease of 0.56 g/L

Compositional Adjustment: Sugar Level

- Add Juice Concentrate
- Arrest fermentation
- Temperature Shock/Add SO_2

Compositional Adjustment: Tannin Removal

- Time of aging: to allow polymerization to occur
- Fining Process
  - Egg whites
  - Gelatin
  - PVPP

Compositional Adjustment: Textural Enhancement

- Lees stirring
- Bio-lees
- Gum-arabic

Selected fining agents with respect to desired effects and potential problems

Activity or Effectiveness

Color reduction	Tannin reduction	Volume of lees formed	Clarity and stability	Potential for overfining	Quality impairment
Carbon	Gelatin	Bentonite	Bentonite	Gelatin	Carbon
Gelatin	Albumen	Gelatin	Carbon	Albumen	Bentonite
Casein	Isinglass	Casein	Isinglass	Isinglass	Casein
PVPP	Casein	Albumen	Casein	Casein	Gelatin
Albumen	PVPP	Isinglass	Gelatin		PVPP
Isinglass	Bentonite	PVPP	Albumen		Albumen
Bentonite	Carbon	Carbon	PVPP		Isinglass

Compositional Adjustment: Sulfide/Mercaptan removal

- Copper sulfate
  - H_2S
  - Mercaptans
- Copper sulfate + Ascorbate
  - Disulfide removal

Sensory Thresholds for Sulfur Compounds

Compound	Sensory description	Range (ppb)
Hydrogen sulfide	Rotten egg, sewage-like	0.9 – 1.5
Ethyl mercaptan	Burnt match, sulfidy, earthy	1.1 – 1.8
Methyl mercaptan	Rotten cabbage, burnt rubber	1.5
Diethyl sulfide	Rubbery	0.9 1.3
Dimethyl sulfide	Canned corn, cooked cabbage, asparagus	17 - 25
Diethyl disulfide	Garlic, burnt rubber	3.6 – 4.3
Dimethyl disulfide	Vegetal, cabbage, onion-like at high levels	9.8 – 10.2
Carbon disulfide	Sweet, ethereal, slightly green, sulfidy	5

Practical Winemaking Solutions - Sulfides

- Limit the late application of sulfur in the vineyard
- Do not add excessive amounts of SO_2 to the must (30 - 50 ppm is adequate for clean fruit)
- Ensure adequate nutrient levels for your yeast choice
- Use macro-aeration and toasted oak during fermentation

Practical Winemaking Solutions – Sulfides (2)

- Evaluate lees for off odors; rack the wine off its lees if it is foul-smelling
- Splash rack after fermentation if sulfides are present
- DO NOT add copper after any aerative procedure; it will catalyze the production of disulfides

Wine Filtration – Why Filter Wine?

- Filtration Objectives/Purposes Include:
  - Remove Insoluble Contaminants
    - Colloids
    - Solids
    - Filter/Treatment aids
    - Spoilage microorganisms
  - Improve clarity, brightness
  - Extend shelf life
  - Protect Organoleptic Properties
    - While adding nothing

Wine Filtration Technologies

- Depth Media – Diatomaceous Earth (DE)
- Depth Media – Sheets, Pads, Lenticular Cartridge
- Membranes – Tangential Flow (TFF)
  - AKA Cross-Flow
- Membranes - Cartridge

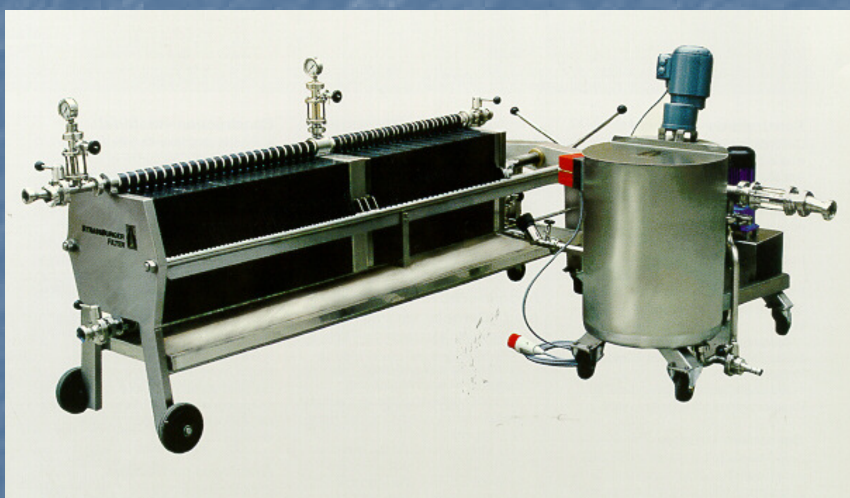
Cross-flow filtration

- Solution is drawn from a tank and pumped into a cross flow device (feed solution)
- Feed solution is moved through the device via a pump used to adjust flow
- Two outlets in a cross flow device:
  - 1^{st} is the permeate (filtrate) that passes through the membrane
  - 2^{nd} is the retentate (feed solution less permeate) and is recycled back to the feed tank
- Back pressure control valve on the retentate is used for controlling the system recirculation loop's pressure

Wine Filtration Technologies: Overview

	DE	Depth	TFF	MF
Materials	Diatoms	Cellulosic	Polymeric	Polymeric
Ratings	≤ 0.5 um Nominal	≤ 0.2 um Nominal	≤ 0.2 um Absolute	≤ 0.2 um Absolute
Applications	Precoat Polishing	Polishing Prefilter	Stabilize Sterilize	Stabilize Sterilize
Advantages	Inexpensive High Capacity	Inexpensive High Capacity	Consistent Rapid Flow	Consistent Testable
Limitations	Nominal Removal	Product loss Color loss	Costly Careful	Costly Careful

Filtration



- Clarification/Polishing: 70 – 5 um
- Prefiltration: 5 – 1.2, 0.8, 0.65 um
- Final Filtration:
  - Microbial Stabilization: 0.6 um
  - Sterile Filtration: 0.6/0.45/0.2 um