FRUIT ROT IN THE MID-ATLANTIC REGION

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***Learning Outcomes*: Summer rains are the norm for the mid-Atlantic region. As such fruit rot issues are a common concern. Even with careful fruit sorting in the vineyard and winery rot can be a big issue. This section outlines the various rot metabolites and practical winemaking to minimize the negative influences. The read should also review the sections on Nutrition and Wine Microbiology.**

Chapter Outline

Section 1.

Introduction

Controlling the incidence of fungal degradation from *Botrytis cinerea* and sour rot is particularly difficult in warm humid climates such as the mid-Atlantic. While virtually every producer conducts some fruit sorting fruit rots remain a problem in my vintages. Our goal should be to enhance our understanding of the constraints to crafting fine wines. Having an established HACCP plan will help to minimize the negative influences of fruit rot.

Temperature, moisture, and the presence of wounds in the fruit have a strong effect on rot development and what organisms dominate during fruit rot. Bird and insect damage are frequently prevalent.

Botrytis cinerea is unique in its parasitology. In rainy weather, the infected grapes do not lose water, and the percentage of sugar remains nearly the same, or may decrease. Although *noble rot* develops regularly and uniformly, *pourriture grise*, or grey rot, is normally heterogeneous. Secondary infection by other microbes may follow.

Under cool and wet conditions, *Penicillium, Mucor*, *and Aspergillus* spp., as well as other fungi and yeast, may overgrow *Botrytis*; this is referred to in France as vulgar rot (*pourriture vulgaire*). Breakdown of the grape skin provides a substrate for the growth of yeasts and acetic acid bacteria, and may produce a condition called *pourriture acide,* or sour rot.

In contrast to the above, *Botrytis* infection followed by warm, sunny, windy weather causes berries to lose moisture by evaporation. With dehydration, shriveling occurs and the sugar concentration increases; this is called *pourriture noble,* or noble rot. Growth of the mold and associated bacteria consumes a portion of the grape sugar. However, the utilization of sugar may be countered by increases in sugar due to dehydration.

Effects of Fruit Rot on Fruit and Wine Chemistry

Fruit rots have significant influence on must chemistry (Table 1). The largest quantitative changes occurring as a result of *Botrytis* growth are those of sugars and organic acids. From 70 to 90% of the tartaric acid, and from 50 to 70% of the malic acid, can be metabolized by the mold. However, the concentration effect resulting from berry dehydration tends to obscure these effects. Change in the tartaric-to-malic acid ratio leads to a reduction in titratable acidity and elevation in fruit pH.

Table 1. Comparison Between Virginia Riesling Musts

Parameter	**"Clean" Grapes**	***Botrytis cinerea***	**Sour Rot**
Brix	18.5	21	≥ 16.0
Titratable Acidity (g/L)	8.0	6.5	5.0
Tartaric + Malic acid (g/L)	7.2	5.2	4.4
pH	3.3	3.5	> 3.4
Gluconic acid (g/L)	0.5	1-5	≥ .5
Acetic acid (g/L)	0	1.1	≥ 1.5
Glycerol (g/L)	Trace	1-10	trace
Ethanol (%, v/v)	0	0-trace	≥ 0.2%
Laccase (µg/mL)	Trace	0.1-8	trace to 0.5
Glucan (mg/L)	0	247	65

Botrytis and sour rot complexes use ammonia nitrogen, reducing the levels available for wine yeast metabolism. Additionally, thiamine (vitamin B_1), and pyridoxine (vitamin B_6) are depleted.

This is a primary reason why wines produced from rot-infected grapes generally require supplementation with nitrogen and vitamins to help avoid protracted fermentations, sticking, and possible sulfur-like off odor formation. Low thiamine levels can also be the result of excessive addition of sulfur dioxide to the must, binding and inactivating this important yeast growth promoter. Like other fungi, *Botrytis cinerea* produces laccase, pectolytic enzymes, and esterases. 2005.

A universal question often asked is how much rot does it take to detrimentally impact a wine? The question is difficult to answer due to the variations in incidence (percentage of clusters with visual rot) severity (percentage of rot per cluster) and the over production of metabolites. As such, the determination of rot should be made based on the analysis of rot metabolites.

A Review of Rot Metabolites

Laccase

Botrytis cinerea strains differ in the production of laccase. Perhaps of greater concern is the oxidation of aroma/flavor compounds. Laccase is resistant to sulfur dioxide, cannot easily be removed with bentonite, and is active in the presence of alcohol, including in bottled wines. Depending upon the juice or wine clarity bentonite may remove enough laccase to help minimize oxidative problems. For analytical methods to determine laccase concentration see Zoecklein et al. 1999, 2005. Levels of laccase concentrations greater than 1U/mL can cause oxidative problems.

Glycerol

Glycerol is an alcohol which is produced by molds. Owing to its relatively-high specific gravity, it may contribute to the overall organoleptic perception of body when fruit glycerol levels are high: 1.04 - 1.15% vs. 0.60 - 1.1% from sound fruit. Most of the glycerol produced by molds will remain inside the defective berry despite berry dehydration, due to the fact that glycerol is non-volatile.

Botrytis-infected fruit has about 150 mg/L glycerol per one percent change in defect level by weight (Pfeffer et al., 1985). *Aspergillus* shows about a 300 mg/L change per one percent defect. Glycerol itself possesses no significant problem for the winemaker.

Gluconic Acid

Infected fruit can contain a relatively-high (25 g/L) gluconic acid level as a result of glucose metabolism. Since gluconic acid is not utilized by yeast or bacteria, it may be used as an indicator of fruit deterioration. Gluconic acid levels in "clean" fruit, and in wines made from clean fruit, are near 0.5 g/L, whereas in wines produced from fruit infected with *B. cinerea*, levels range from 1 to 5 g/L.

The ratio of glycerol to gluconic acid indicates the "quality" of the rot. Higher ratios indicated the growth of true noble rot, whereas lower ratios suggest sour rot.

Acetic Acid

Acetic acid is a normal byproduct of yeast and bacteria. When acetic acid bacteria and yeast are combined with fungal growth, high levels of volatile acidity can be produced. Sour rot complex (production of acetic acid in the presence of bacteria and yeast) may show significant variations in acetic acid content in the fruit. Acetic acid is volatile at normal vineyard temperatures and can be detected by scent during a vineyard stroll.

In some cases, fruit enters the winery showing limited visual rot, only to have excessive acetic acid produced during fermentation. Several species of *Lactobacillus* present in the fruit can convert grape sugars to acetic acid, thus raising the VA excessively, even prior to the completion of alcoholic fermentation.

Ethyl Acetate

The volatile character or "acetic nose" is not exclusively the result of acetic acid production. Acetate esters, most specifically ethyl acetate, contribute significantly to this defect.

Ethyl acetate formation by yeast occurs by chemical esterification, as illustrated below. Ethyl acetate produced by lactic acid bacteria is the result of sugar metabolism, hence the reason that VA may increase significantly during fermentation.

$$C_2H_5OH + CH_3COOH \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-O-C_2H_5 + H_2O$$

Galacturonic Acid

Botrytis causes an increase in the galacturonic acid content as a result of enzymatic hydrolysis of cell wall pectin compounds. Galacturonic acid may be transformed to mucic (galactaric) acid by enzymatic oxidation, and may reach must levels as high as 2 g/L. This acid can combine with calcium to form an insoluble salt, calcium mucate. This can be a large potential problem if the winery water source has a high (> 40 mg/L) calcium level (for additional information, see Calcium Mucate in the *Enology Notes* Index at www.vtwines.info).

Polysaccharides and Instability

One of the greatest impacts of fruit rot is the formation of polysaccharides that create clarification problems. Polysaccharides can form protective colloids in juices and wines, inhibiting clarification. Pectins (complex sugars that hold plant tissues together) are hydrolyzed by mold-produced enzymes, with the formation of soluble pectin and *beta*-1,2- and -1,6-glucans.

In wine, ethyl alcohol causes the pectins and glucan chains to aggregate, thus inhibiting clarification and filtration. Pectinolytic enzymes and glucanase enzymes are available to minimize these clarification problems. Zoecklein et al. (1995, 2005) provide two simple lab procedures for determining pectin and glucan instability. It is highly recommended that wines be evaluated for filterability and/or pectins/glucans prior to filter set-up. This will save a great deal of time and money.

Aroma and Varietal Character

In some seasons, the general environmental constraints (limited fruit maturity, uneven maturity) in part contribute to limited varietal character. Additionally, aroma compounds can be lost as a result of the oxidizing effect of fruit rots. Metabolites such as gluconic acid, oxidase enzymes, volatile esters, aldehydes, and traces of other organic compounds may alter grape aroma/flavor compounds or their aroma intensities. For an analysis of the presence of laccase, see Zoecklein et al. (1995, 2005).

Post-fermentation addition of pectinolytic enzymes may increase grape-derived aroma intensity. Most pectinolytic enzymes contain glycosidases which can convert grape aroma/flavor precursors to their odor-active forms. Additional information is available in the *Enology Notes* Index at www.vtwines.info.

Muté Production

Mutés (juice held, or mutéd, from fermentation) can add life and freshness back into the base wine. A small quantity of muté produced from non-degraded fruit can help recover lost aroma, while masking some of the acetic and oxidized tones which may have resulted from sour bunch rot. Specifics regarding muté production are discussed in the module entitled Controlling Microbial Growth in Wine

Production Considerations

The following are a few additional considerations to keep in mind in a season where the threat of fruit rot is high. Details regarding each item listed are provided in previous *Enology Notes* found at www.vtwines.info.

- Crop level: Avoid over-cropping, which could delay maturity.

- Fruit culling: Cull as much fruit rot out as possible in the field.

- Fruit sorting: Sort fruit at the winery. A very small concentration of rot can have a large impact. It is not the incidence of rot, but the level of various rot metabolites that determine how much rot is acceptable. The best rule of thumb: no rot is acceptable.

- Rinse fruit: You may consider rinsing the fruit with water if the fruit delivered to the winery is high in rot. That will help to lower some of the sour rot metabolites and late season spray residues. This is not practical for large volumes. This practice can slightly lower the Brix level as a result of dilution.

- Muté production/cryoextraction: A small quantity of muté produced from non-degraded fruit can help recover lost aroma and aroma intensity resulting from sour bunch rot.

- Dehydration: Only extremely "clean" fruit should be used for this style of wine production.

- Pressing: Whole cluster press whites by discarding the initial juice. Press very lightly and take press fractions.

- pH adjustment: Adjust the juice pH – the lower, the better. Expect about 2.0 g/L TA will drop out during fermentation or shortly following completion. Some seasons, high pH values cause many to have both biological and oxidative problems.

- Sulfur dioxide: Keep the initial sulfur dioxide level low during pressing. You want the low molecular weight tannins to polymerize or bind together. Then raise the sulfur dioxide, depending on the fruit condition and pH.

- Cold settle: Adequate cold settling with the use of pectinolytic enzymes will help lower the level of rot metabolites.

- Tannin addition: You could add enological tannin. That would help clarify the juice and bind with some of the rot-produced enzymes. Tannins can act as oxygen buffers and may bind with enough protein to lower the bentonite requirement needed for wine protein stabilization. This is an important consideration for rather delicate varieties such as Pinot gris and Sauvignon blanc.

- Pectinolytic enzymes: The addition of pectic enzymes aids in clarification, which is particularly important if juice is produced from compromised fruit.

- PVPP: Add some PVPP inline to the juice if there is a high level of grape tissue degradation.

- Ascorbic acid: For varieties where the oxidation potential is large, add ascorbic acid to the juice.

- Test YAN: Test the YAN (yeast assimilable nitrogen) content and make adjustments accordingly. Rots deplete YAN. Note that rots also lower the micronutrient levels. As such, the addition of a complex nutrient formulation, not simply DAP, is wise.

- Measure the NTUs: You want to ferment fairly-clean juice. Measure the NTUs (nephelos turbidity units) if you can. If you measure, you will want about 100 to 150. Again, if the juice is not clarifying, you may want to add enzymes or more tannin. Don’t add them together.

- Inoculation: Inoculate with a high volume of a vigorous, not too N-dependent yeast. Use more than the standard 24 g/hL or 2 lb/1000 gallons. Make sure the starter is properly prepared, and understand that oxygen is a yeast nutrient.

- Co-ferment: If you are planning on an MLF co-fermentation, make sure you check with your suppliers regarding yeast and MLF strain compatibility. If you do not desire an MLF, consider the use of lysozyme.

- Fermentation temperature: Begin the fermentation at a slightly warmer temperature to help lower the concentration of undesirable aroma characters, and to assure a rapid yeast fermentation.

- Mid-fermentation racking: Rack mid fermentation. This helps to remove wine from the primary lees.

- Rack immediately post-fermentation.

- Consider short vatting reds, avoid cold soak and extended post-fermentation maceration. Use short vatting, and possibly délestage, to help remove fermenting wine from lees. Ferment in the presence of non-toasted wood and carefully review the steps listed above. If cold soak is done it should only occur with clean fruit. A cultured yeast should be added after adjustment to the cold soak temperature to avoid temperature shock.

Study Questions

1. Why is it so difficult to define the incidence level of rot below which there would be not negitive impact on wine quality?
2. In wet seasons the impact of fruit rot is compounded by the potential for residue vineyard spray residue. Outline steps to ovoid this problem.
3. Fruit rots offen impact fermenations, both yeast and bacterial. Outline the steps to be taken to minize fermentation difficulties with rot-compromized fruit.

References

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