Determining bunch rot impact on wine quality

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Introduction

Bunch rot diseases of grapes are a worldwide problem in vineyards when rain occurs close to harvest. Bunch rots are caused by a number of filamentous fungi; the most common is *Botrytis cinerea*, which is responsible for botrytis bunch rot (commonly referred to as grey mould; (Figure 6). Botrytis can occur in tightly packed clusters and might be hidden from visual assessment within the bunch. Management of grey mould in the vineyard is based on strategically targeted sprays at different phenological stages of growth, management of the vine canopy and selecting appropriate grapevine varieties.

Aside from *Botrytis cinerea*, a number of other fungal species are responsible for the rotting of grapes close to harvest. Their occurrence in the vineyard is driven by climatic conditions and is more prevalent if the berries in a bunch are damaged. Such organisms are referred to opportunistic pathogens, causing disease when the opportunities for infection are suitable. This group includes fungi such as *Aspergillus* (Figure 7) and *Penicillium* (Figure 8). Aside from diminishing yields, the organisms responsible for the rotting of grapes have negative impacts on grape and wine quality.

Figure 6. Grey mould (*Botrytis cinerea*) on *Vitis vinifera L* (cv Chardonnay).

Figure 7. *Aspergillus niger*, a non-botrytis bunch rot that occurs as an opportunistic pathogen of grapes.

Figure 8. *Penicillium expansum*, a non-botrytis bunch rot that occurs as an opportunistic pathogen of grapes.

Why does management of bunch rots fail in the vineyard in some seasons?

Despite a considerable amount of information available on botrytis grey mould of grapes, management of this destructive disease often fails. Current management practices for bunch rots include a combination of cultural practices (e.g. canopy management and varietal selection) and chemical control. While these practices are effective in low disease pressure years, bunch rot management frequently fails in years that have high rainfall. Furthermore *B. cinerea* is ubiquitous in the vineyard environment and is readily isolated from companion crops. This inoculum source in the vineyard is difficult to eliminate.

Many effective fungicides cannot be applied to wine grapes post-véraison because of maximum residue limit (MRL) restrictions imposed by export regulations. Consequently, when bunch rot occurs, growers are faced with decisions about when and if to harvest the fruit. While there have been significant advances in botrytis detection, accurate determination of the amount of fungal rot present in a parcel of fruit and the potential impacts on wine quality remain imprecise.

Detecting fungal taints in grapes before they are turned into wine will reduce un-needed wine production costs. It will also allow for more accurate determination of bunch rot thresholds in wine grapes.

Impacts of botrytis on grape and wine composition and thresholds for contamination

Fungal taints caused by botrytis and other bunch rotting fungi are described as having mouldy, mushroom and earthy characters. Many have low odour perception thresholds and have a negative impact on wine quality. To determine how much grey mould can be tolerated in wine grapes before there is a noticeable loss of wine quality, Chardonnay grape bunches from a commercial vineyard were divided into one of five groups and scored for botrytis infection using a scale of 0–4 based on visual assessment (Figure 9). However, subjective measures of fungal contamination of grapes are prone to errors. Therefore, to more accurately quantify the level of fungal contamination, ergosterol, a component of fungal membranes that is not normally found in healthy plant tissues was also measured. This allowed the dry weight of fungal biomass per kilogram wet weight of grapes to be calculated.

The grapes were then vinified in eight kilogram triplicate batches at the Charles Sturt University winery. Juice and finished wine samples were analysed for volatile organic compounds by gas chromatography–mass spectrometry (an analytical method used to identify different substances within a test sample). Sensory analysis using a triangle test (a discriminative method where a panel assess samples to determine whether shifts in processing or ingredients have significantly changed a product) was conducted on the finished wines.

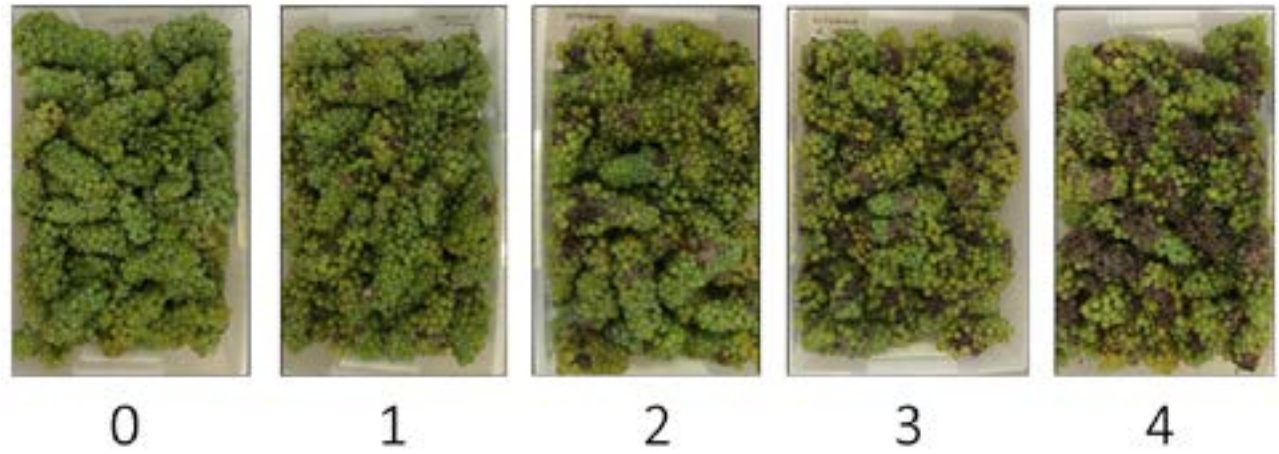

Figure 9. Chardonnay grape bunches from a commercial vineyard were divided into one of five groups and scored for botrytis infection using a scale of 0 – 4 based on visual assessment. Subsequent ergosterol analysis indicated that the level of fungal contamination of these five batches of grapes was: 0 = 0.07, 1 = 0.34, 2 = 1.05, 3 = 1.82 and 4 = 5.15 g dry weight of fungus per kilogram wet weight of grapes. Low levels of ergosterol are expected in the control (Level 0) grapes due to the background yeast population on the berry surface.

Grey mould infection resulted in elevated levels of compounds associated with earthy mouldy aromas (i.e. 1-octen-3-ol (Figure 10), 1-octen-3-one (Figure 11) and 3-octanone. Geosmin (Figure 12), reported previously in grapes infected with grey mould, was not detected. Desirable flavour compounds, such as beta-damascenone which is responsible for floral, fruity aromas, were diminished. Levels of earthy mouldy aromas lessened during wine making, however, they remained above the sensory perception threshold in the more severely affected batches of fruit. Sensory analysis using a triangle test indicated that wine made from grapes with ≥ 1.05 g of dry weight of fungus per kilogram wet weight of grapes was perceived as different from wine made with uninfected grapes. Participants could not differentiate wine made with 0.34 g dry weight of fungus per kilogram wet weight of grapes from unaffected wine. This suggests that the threshold for botrytis contamination is between 0.34 to 1 g fungal dry weight per kilogram fresh weight of grapes range (Table 6).

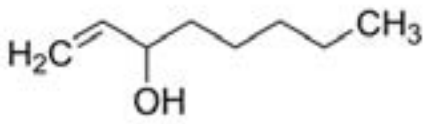

Figure 10. 1-Octen-3-ol.

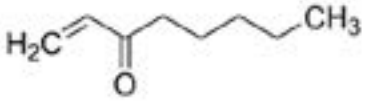

Figure 11. 1-Octen-3-one.

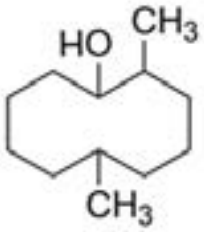

Figure 12. Geosmin.

Table 6. Sensory analysis of wine made from Chardonnay grapes infected with different levels of grey mould.

Comparison of grey mould infected levels*	Number of correct responses out of 15	Significance
0 vs. 1	8/15	NSD
0 vs. 2	13/15	SD ($p<0.01$)
0 vs. 3	12/15	SD ($p<0.01$)
0 vs. 4	15/15	SD ($p<0.01$)

NSD = no significant difference. SD = significantly different. *Grey mould levels of contamination were: 0 = 0.07, 1 = 0.34, 2 = 1.05, 3 = 1.82 and 4 = 5.15 g dry weight of fungus per kg wet weight of grapes.

Conclusions and further work

Results to date indicate that if the amount of bunch-rotting fungus present in the grapes exceeds 1.05 g of fungus per kilogram of grapes, then wine made from these infected grapes will have unwanted off flavours. Some of these off flavours and aromas are common to a wide range of fungi in addition to botrytis and further work is required to more accurately determine thresholds and bunch rot type.

During the 2018–19 growing season this work was extended to include a Chardonnay vineyard in the Tamar Valley in Tasmania. Grapes harvested from this vineyard have been vinified and the wines are undergoing analysis. Future work will also investigate more accurate measures of botrytis in the vineyard and winery.

This work aims to provide grape growers and wine makers with a better understanding of how fungal rots affect wine production. Improvements in objective measures of quality will allow decisions to be made around harvesting fruit that is affected with fungal bunch rots.

Further information

Steel, CC 2018, 'Grape bunch rots and thresholds for wine contamination', AWRI webinar, 19 January 2018. https://www.youtube.com/watch?v=5B-qp4umOBo&feature=youtu.be

Steel, CC, Blackman, JW and Schmidtke, LM 2013, 'Grapevine bunch rots: impacts on wine composition, quality, and potential procedures for the removal of wine faults', *Journal of Agricultural and Food Chemistry*, 61: 5189-5206. doi: 10.1021/jf400641r.

Acknowledgements

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