THE IMPACTS OF FROZEN MATERIAL-OTHER-THAN-GRAPES (MOG) ON AROMA COMPOUNDS OF RED WINE VARIETIES

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Abstract:
Context and purpose of the study - An undesirable note called "floral taint" has been observed in red wines by winemakers in the Niagara region caused by large volumes of frozen leaves and petioles [materials-other-than-grapes (MOG)] introduced during mechanical harvest and subsequent winemaking late in the season. The volatiles, which we hypothesized are responsible, are primarily terpenes, norisoprenoids, and specific esters in frozen leaves and petioles. The purpose of this study was to investigate the volatile compounds which may cause the floral taint problem and explore how much of them (thresholds) may lead to the problem. Also, the glycosidic precursors of some of these compounds were analyzed to see the changes happening during frost events.
Materials and methods - Research winemaking was conducted in 2016, 2017 and 2018. All fermentations were based on 40-kg replicated ferments of Cabernet Franc (CF) and Cabernet Sauvignon (CS). MOG Treatments were (by weight): 0, 0.5%, 1%, 2% and 5% petioles, and 0, 0.25%, 0.5%, 1%, and 2% leaf blades. In 2017 and 2018, different yeast strains and harvest strategies were also included in the CF treatments. Yeast treatments included CSM, EC1118 and FX10. Harvest strategies involved conventional machine harvesting (MH), Braud-New Holland Opti MH, Gregoire 8 MH, MH + optical sorting, and MH with pre-harvest leaf removal. Concentrations of key odor-active compounds were quantified by gas chromatography-mass spectrometry with stir bar sorptive extraction.
Results - Several compounds including cis- and trans-rose oxides, β-ionone, citronellol, linalool, eugenol, methyl and ethyl salicylate were higher in MOG treatments for both CF and CS and their concentrations increased linearly with the accumulative levels of petioles or leaves. Principal components analysis showed petiole and leaf treatments were separated apart from the control sample with the 5% petioles and 2% leaves as the extremes. Petiole and leaf treatments were spread out on different axes, which indicated their large differences in volatile compositions. Interestingly, eugenol and rose oxides and many other compounds followed linear curves with the addition of petioles and leaves in the 2016 vintage, which could be potentially used as a tool to communicate with winemakers on potential floral taint risk based on their sensory thresholds. Preliminary results from 2017 showed that more terpene compounds were found in the standard MH treatment than the hand-harvested control, and the yeast EC1118 produced the least terpenes out of three different yeasts among all leaf and petiole addition treatments in most cases, while yeast strain FX10 produced the highest terpene concentrations. In general, petiole additions contributed more to the floral taint problem than leaf additions. Specifically, petioles contributed terpenes and salicylates (floral notes) to the wines, and leaves contributed norisoprenoids and C6 alcohols (green notes).
Keywords: MOG, floral taint, yeasts, harvest strategies, leaves, petioles, GC-MS, terpenes.

1. Introduction.

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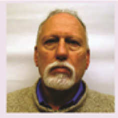

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Abstract

An undesirable note called "floral taint" has been observed in red wines by winemakers in the Niagara region caused by large volumes of frozen leaves and petioles [materials-other-than-grapes (MOG)] introduced during mechanical harvest and subsequent winemaking late in the season. The volatiles, which we hypothesized are responsible, are primarily terpenes, norisoprenoids, and specific esters in frozen leaves and petioles. The purpose of this study was to investigate the volatile compounds which may cause the floral taint problem and explore how much of them (thresholds) may lead to the problem. Also, the glycosidic precursors of some of these compounds were analyzed to see the changes happening during frost events. Research winemaking was conducted in 2016, 2017 and 2018. All fermentations were based on 40-kg replicated ferments of Cabernet Franc (CF) and Cabernet Sauvignon (CS). MOG Treatments were (by weight): 0, 0.5%, 1%, 2% and 5% petioles, and 0, 0.25%, 0.5%, 1%, and 2% leaf blades. In 2017 and 2018, different yeast strains and harvest strategies were also included in the CF treatments. Yeast treatments included CSM, EC1118 and FX10. Harvest strategies involved conventional machine harvesting (MH), Braud-New Holland Opti MH, Gregoire 8 MH, MH + optical sorting, and MH with pre-harvest leaf removal. Concentrations of key odor-active compounds were quantified by gas chromatography-mass spectrometry with stir bar sorptive extraction. Several compounds including cis- and trans-rose oxides, β-ionone, citronellol, linalool, eugenol, methyl and ethyl salicylate were higher in MOG treatments for both CF and CS and their concentrations increased linearly with the accumulative levels of petioles or leaves. Principal components analysis showed petiole and leaf treatments were separated apart from the control sample with the 5% petioles and 2% leaves as the extremes. Petiole and leaf treatments were spread out on different axes, which indicated their large differences in volatile compositions. Interestingly, eugenol and rose oxides and many other compounds followed linear curves with the addition of petioles and leaves in the 2016 vintage, which could be potentially used as a tool to communicate with winemakers on potential floral taint risk based on their sensory thresholds. Preliminary results from 2017 showed that more terpene compounds were found in the standard MH treatment than the hand-harvested control, and the yeast EC1118 produced the least terpenes out of three different yeasts among all leaf and petiole addition treatments in most cases, while yeast strain FX10 produced the highest terpene concentrations. In general, petiole additions contributed more to the floral taint problem than leaf additions. Specifically, petioles contributed terpenes and salicylates (floral notes) to the wines, and leaves contributed norisoprenoids and C6 alcohols (green notes).

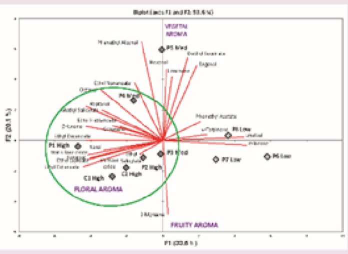

Figure 1. Principal components analysis of several commercial Ontario red wines with various levels of MOG-induced floral taint; 2015.

Introduction, Objectives, Hypotheses

- Has always been an issue since the advent of mechanical harvesting
- Continual improvements in harvester technology has reduced the problem significantly
- However—regions with cold winters that grow late-season red varieties (e.g. Cabernet Sauvignon) have, due to climate change, been harvesting fruit much later in the season than traditional late October
- The consequence has been mid-November harvests after hard frosts, and the incorporation of MOG into loads at very high levels
- This "frozen MOG" has led to issues of anomalous aromas—"floral taint" in late-season red wine
- Based on anecdotal evidence, we anticipated these contributions from MOG:
  - Increases in terpenes and other odorants
  - Increases in low molecular weight phenols and other bitter taste compounds
  - Malic acid increase from leaves and petioles
  - Increased metal content (Na, K, Mg, Fe)
  - Decreased anthocyanins and color intensity
  - Reduced methoxypyrazines due to light freezing of grapes
  - Breakdown of glycosides in leaves, petioles, and fruit—and subsequent release of terpenes and norisoprenoids is ongoing.

Materials & Methods

- 2015 vintage--tanks of several 2015 vintage Cabernet franc and Cabernet Sauvignon wines previously identified by the winemakers as having "floral taint" were sampled (3 x 500 mL) from Andrew Peller Ltd. (APL) and Arterra wineries
- Several APL commercial wines both displaying/ not displaying floral taint were likewise sampled
- All with extracted using the Gerstel stir bar technology and subjected to GC-MS
- Sensory analysis of 2015 commercial wines was carried out by ≈20 panelists using multidimensional sorting
- 2016-2018 vintages-- Controlled fermentations with Cabernet franc and Cabernet Sauvignon took place in November 2016 to 2018 involving several levels of frozen leaves (0, 0.25, 0.5, 1, 2%) and petioles (0, 0.5, 1, 2, 5%)
- Wines were subjected to GC-MS analysis and sensory evaluation
- 2017-2019 vintages--Combined leaf and petiole treatments with different yeast strains (CSM, EC1118, FX10)
- Field trials involving different harvest treatments
  - Hand Harvest
  - Machine Harvest
  - Leaf removal prior to harvest (mechanical)
  - Machine Harvest with Opti-Sorting
  - Machine Harvest using Gregoire GR8 (2018 only)
  - Machine Harvest followed by optical sorting table (2017 only)

Table 1. Means of several aroma compounds of several commercial red wines from Ontario with various levels of MOG-induced floral taint.

Sample	β-Ionone	α-Ionone	β-Damascenone	Citronellol	Geraniol	cis-Rose oxide	trans-Rose oxide	γ-Terpinene	Limonene
Threshold	0.09	2.6	0.05	100	30	0.2	450	—	15
Mean Low	0.171	2.45	2.42	1.06	5.18	0.027	0.007	0.030	0.13
Mean Med-High	0.257*	3.42	3.83*	1.30*	6.12*	0.062*	0.012*	0.087	0.10
OAV	2.86	0.13	69.4	0.012	0.205	0.400	0.053	—	0.018
Sample	Ethyl hexanoate	Ethyl heptanoate	Ethyl octanoate	Ethyl nonanoate	Ethyl decanoate	[illegible]	Octanol	Phenethyl acetate	Phenethyl alcohol
Threshold	5	2.2	5	—	200	1	110	250	10000
Mean Low	176.8	0.17	200.6	0.11	47.1	31.2	10.54	39.2	42000
Mean Med-High	229.9*	0.61*	332.5*	0.10*	100.7*	34.7*	15.75*	41.6*	45902*
OAV	45.98	0.15	66.5	—	0.5	11.2	0.143	0.167	4.59

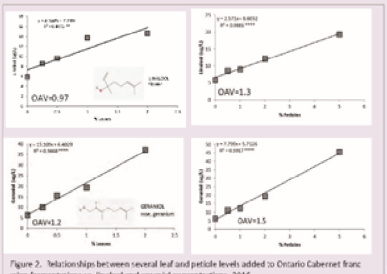

Figure 2. Relationships between several leaf and petiole levels added to Ontario Cabernet franc wine fermentations vs. linalool and geraniol concentrations, 2016.

Results

- Commercial red wines from the 2015 vintage that were rated as medium to high in floral taint were associated with several aroma compounds through PCA (Fig. 1).
- Several aroma compounds were substantially higher in concentration in the medium/high-rated wines (Table 1)
- Several aroma compounds increased linearly with increased additions of leaves and petioles in 2016 and 2017 (Fig. 2). These included terpenes (linalool, geraniol, nerol, citronellol, citral, cis-rose oxide); norisoprenoids (β-damascenone, α-ionone, β-ionone); higher alcohols and salicylates (hexanol, octanol, methyl salicylate, ethyl salicylate).
- Yeast strain had an impact on MOG-containing fermentations, with FX10 reducing concentrations of numerous compounds (Fig. 3,4).
- Opti-Harvest and optical sorting reduced concentrations of linalool oxides, and cis- and trans-rose oxide, but ethyl nonoate and ethyl isobutyrate increased (Fig. 5).

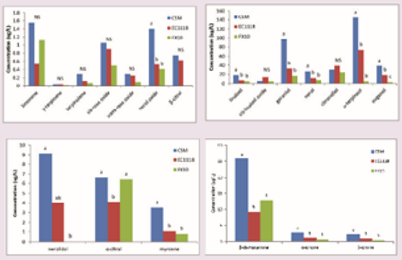

Figure 3. Impact of three yeast strains on aroma compounds in Cabernet franc wines to which 2.5% frozen leaves were added pre-fermentation.

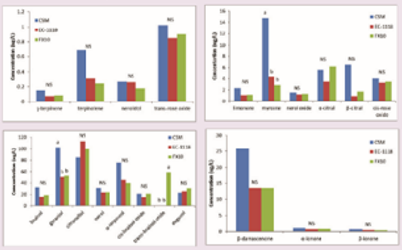

Figure 4. Impact of three yeast strains on aroma compounds in Cabernet franc wines to which 5% frozen petioles were added pre-fermentation.

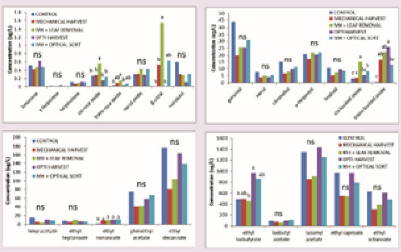

Figure 5. Impact of harvest protocols on aroma compounds in Ontario Cabernet franc wines 2017.

Acknowledgements

GRAPE & WINE RESEARCH · Ontario Centres of Excellence · Huebel Grapes Estates · LAKEVIEW · ANDREW PELLER LIMITED · ARTERRA WINES CANADA · VINELAND ESTATES WINERY · DIAM

Conclusions

- "Floral taint" associated with frozen MOG is due primarily to several terpenes (linalool, geraniol, *cis*- and *trans*-rose oxide, citronellol, nerol), methyl and ethyl salicylate, and ß-ionone
- Several esters and other aliphatic compounds also appear to be related—including phenethyl alcohol; ethyl heptanoate, octanoate, nonoate and decanoate; hexanol, octanol
- However—some of these, although very responsive, may be below threshold. But, (a) Most thresholds have been measured in water and are much lower in alcohol, and (b) There are lots of interactions between chemicals that we don't fully understand.