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Modeling Impacts of Viticultural and Environmental Factors on 3-Isobutyl-2-Methoxypyrazine in Cabernet franc Grapes

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Background. Cabernet franc is a popular variety grown in many wine regions, but in cool climates its wines are often assumed to have intensely herbaceous aromas associated with methoxypyrazines (MPs).The predominant MP, 3-isobutyl-2-methoxypyrazine (IBMP) is associated with green bell pepper aromas which can mask fruity aromas in red wines. Because the majority of IBMPs reside in grape skins and are readily extracted during winemaking, we are interested in identifying viticultural practices that can reduce the MP concentration of grape berries. The objective of this study was to develop models to predict which viticultural practices affect the accumulation and degradation of IBMP in grape berries.

Experimental design. Over the course of two seasons (2008 and 2009), data was collected in Cabernet franc vineyards throughout New York State. At each site, the vines and canopies were characterized (trellis/training system) prior to fruit and data collection. Weather data was collected at each site, and berries were collected for fruit analysis at 30 days after anthesis, 50 days after anthesis, and harvest. In addition to measuring the photosynthetic capacity of berries and leaves at 50 days after anthesis, shoot lengths and cane weights were also measured to evaluate vine vigor. Berries were analyzed for soluble solids, titratable acidity, pH, and IBMP concentration. At harvest, fruit was crushed, pressed, and fermented in small lots for IBMP and sensory analyses by a trained panel. Finally, statistical analyses were used to develop models using over 120 viticultural and environmental variables to explain IBMP accumulation and degradation in grape berries. In the finished wines, we evaluated whether berry IBMP levels affect the final IBMP concentrations and whether 'herbaceous' aromas were perceivable.

Results. The concentration of IBMP was higher in grapes grown during the warmer 2008 growing season than in the cooler 2009 growing season. IBMP concentrations in fruit increased during the interval from 30 days after anthesis to 50 days after anthesis and then decreased

from 50 days after anthesis to harvest. One parameter that was important, however, in predicting IBMP concentrations at 50 days after anthesis and at harvest was the air temperature. Higher temperatures from anthesis to 50 days after anthesis led to an increase in IBMP concentrations in berries.

Overall, variables associated with vine vigor, such as shoot length and water status at 50 days after anthesis, best predicted the concentration of IBMP in berries. In other words, vigorous vines had accumulated greater concentrations of IBMP by 50 days after anthesis, which was the case in 2009, when vines grew more vigorously than in 2008. The twist here is that in 2008, pre-veraison temperatures were warmer, which likely led to higher IBMP concentration in berries that year. Although previous work has shown that cluster exposure to sunlight can reduce IBMP formation within a site, cluster exposure was not an important predictor of IBMP formation across sites in this study.

Not surprisingly, concentrations of IBMP in berries correlated with the concentration of IBMP in the wines. However, the herbaceous aroma of the wine was not directly related to the concentration IBMP, possibly because the IBMP levels were well below or just at the sensory detection level.

Conclusions

- The herbaceous aromas in the wines were not correlated with the concentration of IBMP, which barely reached the sensory threshold of 15 picograms/milliliter.

- Unexpectedly, the intensity of herbaceous aromas was inversely correlated with vine vigor and water availability.

- Factors such as crop to vine size, vine vigor, and fruit maturity could be used to predict post-veraison IBMP degradation; however, pre-veraison factors were better predictors.

- Vines with excessive vigor, where the pre-veraison temperatures are warm and fruit maturation is delayed, are more likely to produce fruit with higher concentrations of IBMP.

The bottom line: The most important predictor of herbaceousness in wine was the vine water status, with low water status increasing herbaceousness.

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