Volatile Acidity

Analysis of volatile acidity (VA) was probably the wine industry's first measure of wine quality and is routinely used as an indicator of wine spoilage. This column looks at some of the questions AWRI helpdesk staff commonly receive about VA.

What exactly is volatile acidity?

Volatile acidity is a measure of the low molecular weight (or steam distillable) fatty acids in wine and is generally perceived as the odour of vinegar. Winemakers are usually most concerned with acetic acid, which accounts for more than 93% of steam distillable acids in wine (Buick and Holdstock 2003). However, other contributors include carbonic acid (from carbon dioxide), sulfurous acid (from sulfur dioxide), lactic, formic, butyric and propionic acids. Sorbic acid is also steam distillable and will contribute to the VA if it has been added to wine. Rather than conducting a steam distillation, many wine laboratories just analyse for acetic acid. Acetic acid is not the full story though, as ethyl acetate can affect the sensory perception of VA. Ethyl acetate (EA) is typically perceived as the odour of nail polish remover.

What is the sensory threshold for VA?

Corison et al. (1979) reported the sensory thresholds for acetic acid and EA in a red table wine as 0.74 g/L and 0.16 g/L, respectively. These authors also reported the rejection thresholds for acetic acid and EA as 0.9 g/L and 0.115 g/L, respectively, for the same red wine. Work conducted at the AWRI found the threshold for acetic acid to be about 0.7 g/L in a red table wine.

Ribéreau-Gayon et al. (2006) indicate that VA is not easily detected below 0.72 g/L, but above this level wine aroma starts to be affected and flavour starts to deteriorate, such that at acetic acid levels of 0.90 g/L and above, the wine has a noticeable 'harsh', 'bitter' and 'sour' aftertaste.

Why is VA obvious in one wine but not in another, similar wine with the same level of acetic acid?

VA is more easily detected if a small amount of EA is also present, and in some cases EA aroma can dominate. Consequently, if two wines have the same concentration of acetic acid but one of them has an elevated level of EA, then the VA can be perceived to be elevated in the wine with the higher level of EA. In addition, VA intensifies the taste of the other acids and tannins present in wine, but can be masked by high levels of sugar. This can also explain why VA might be perceived in a wine with a relatively low level of acetic acid but not noticed in another wine with a higher level of acetic acid (Zoecklein et al. 1995).

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What is a 'normal' level of VA?

Data collated from AWRI Commercial Services' database of analytical results from the 2000–2008 vintages show that the average VA value for red table wines during this period was 0.60 g/L. The average VA value for white table wines was 0.43 g/L for the same vintages (Godden and Muhlack 2010). More recent, unpublished data from the same source suggests that the average acetic acid levels in red and white table wines may have decreased, with current levels approximately 0.05 g/L lower than those quoted above.

What are the main sources of VA?

Yeast produce small amounts of acetic acid during fermentation as a by-product of normal metabolism. Lactic acid bacteria (LAB) can cause a slight increase in acetic acid concentration, if malolactic fermentation is conducted, due to metabolism of citric acid. Small amounts of acetic acid and EA are also produced by acetic acid bacteria (typically Acetobacter sp.) during storage of wine in oak barrels. Unless membrane filtered, red wines always contain some Acetobacter. These bacteria are obligate aerobes (i.e. they have an absolute requirement for oxygen) and produce small amounts of VA whenever the wine is exposed to air, such as during racking and when barrels are topped (Ribéreau-Gayon et al. 2006).

These sources of VA, which are attributable to typical winemaking processes, lead to the 'normal' levels of VA indicated in the previous answer. However, other circumstances can lead to elevated levels of VA. For example, aerobic yeasts can grow on the surface of wine in ullaged tanks, producing varying concentrations of EA and acetic acid, depending on the species. Aerobic yeasts use ethanol as a substrate and typically also produce high levels of acetaldehyde (Sponholz 1993). LAB, such as species of Lactobacillus, can produce acetic acid from growth on both hexose and pentose sugars, while species of Pediococcus can also produce acetic acid from growth on pentose sugars. While uncontrolled growth of LAB can lead to high levels of acetic acid, their growth does not lead to the production of EA. However, uncontrolled growth of Acetobacter can lead to high levels of both acetic acid and EA. Like the aerobic yeasts, Acetobacter can multiply and spoil wines that are exposed to air via the oxidation of ethanol, so wine vessels must be kept full and well-sealed to avoid this spoilage.

Damaged fruit, caused by fungal disease or bird attack, and the associated increased populations and growth of indigenous microorganisms, can also lead to elevated levels of VA, even before inoculated yeast have had time to establish (Coulter et al. 2008).

For further information on volatile acidity, please contact the AWRI helpdesk on helpdesk@awri.com.au or 08 8313 6600.

References

Buick, D., Holdstock, M. 2003. The relationship between acetic acid and volatile acidity. AWRI Tech. Rev.(143): 39-43.

Corison, C. A., Ough, C. S., Berg, H. W., & Nelson, K. E. 1979. Must acetic acid and ethyl acetate as mold and rot indicators in grapes. Am. J. Enol. Vitic. 30(2), 130-134.

Coulter, A.D., Henschke, P.A. Simos, C.A. Pretorius, I.S. 2008. When the heat is on, yeast fermentation runs out of puff. Aust. N.Z. Wine Ind. J. 23(5): 29-33.

Godden, P. Muhlack, R. 2010. Trends in the composition of Australian wine. 1984–2008. Aust. N.Z. Grapegrower Winemaker (558): 47–61.

Ribéreau-Gayon, P.; Glories, Y.; Maujean, A; Dubourdieu. 2006. Handbook of Enology Second Edition Volume 1: The Microbiology of Wine and Vinifications. Chichester: John Wiley & Sons Ltd: 59, 191, 238.

Sponholz, W.R. 1993. Wine Spoilage by Microorganisms. Fleet, G.H. ed. Wine microbiology and biotechnology. Singapore: Harwood Academic Publishers: 395–420.

Zoecklein, B.W., Fugelsang, K.C., Gump, B.H. and Nury, F.S. 1995. Wine analysis and production. New York: Chapman & Hall: 197.