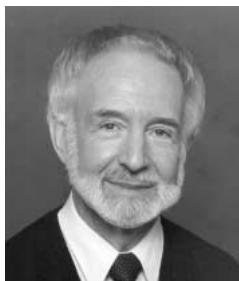


Wine Science

Dr Ron Jackson

Screwcaps come under scrutiny, following claims of off-odours.



DR RON JACKSON

A few years ago, the Australian Wine Research Institute (AWRI) carried out a comprehensive study on wine closures, including cork, cork substitutes, and screwcaps. Of the many findings, data from the screwcap studies have attracted the most attention. Screwcapped wines retained their fruity/floral character and showed no oxidation or corky off-odours. Independent studies on screwcaps have

demonstrated that Riesling wines can retain their fruity character for upwards of 30 years. However, a few samples in the AWRI study showed rubbery or other sulphide off-odours. This finding has sparked much debate. Those favouring cork closures argue that limited oxygen uptake (associated with cork use) neutralizes hydrogen sulphide and other reduced-sulphur compounds. Such compounds could exist in the wine before bottling (where they may be masked by other flavourants or by bonding with non-volatile compounds) or could occur subsequent to bottling. Others counter that the presence of reduced-sulphur odours indicates inadequate preparation before bottling and that the problem is not related to the type of closure. Reduced-sulphur odours can occur in wines sealed with any type of bottle closure.

The closure issue has highlighted one of the controversial issues in winemaking – does the limited uptake of oxygen in cork-sealed bottles

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have benefits? For the majority of white wines, there is general agreement that any post-bottling oxidation is detrimental. However, anecdotal evidence suggests that for some wines, such as Sauvignon Blanc and Shiraz, slight in-bottle oxidation may be beneficial. There is no doubt that oxygen can deactivate the rotten-egg smell of hydrogen sulphide, and circumstantial evidence indicates that oxygen slowly negates the burnt-rubber smell of 2-mercaptoethanol. Whether slow or intermittent oxygen ingress aids, or is essential to, the formation of a desirable aged character in older red wines is unknown from a purely scientific perspective. Although limited oxygen uptake is associated with cork closures, its occurrence is variable and unpredictable. The same is true for synthetic corks. Any potential benefit from marginal oxygen uptake cannot therefore be guaranteed.

Of one thing we can be certain – the controversy over the ‘best’ sealant for wine is going to continue. However, from the rate at which wineries are adopting screwcap closures, we will soon be able to make our own decisions on the relative merits of screwcaps. The retention of the fresh, fruity character of young wines will undoubtedly please most consumers. Concerns about how to lay down wines in a cellar will be gone – upright will be as good as horizontal. Whether screwcaps will retard the development of an aged (oxidized?) character of ‘fine’ wines is a moot point. This may not be known for years.

Grapevine

- **ProCork®** is offering corks coated with a membrane that possesses specified oxygen permeability. Membranes impervious to TCA are apparently also available.
- **Screwcap producers** are working on different polymers for their inner-cap sealant, which will possess specified oxygen permeability.
- **Barrelmate®** is a device designed to promote ‘desirable’ microoxidation of wines matured in barrels. It purportedly eliminates the need for manual racking to obtain the oxygen exposure that its proponents say produce better flavour, milder tannins, and improved wine structure. Scientists who have instituted studies on the effects of microoxidation on wine phenolics and its sensory effects may answer this thorny issue.
- **Wine, like any food or beverage,** can become contaminated with natural toxins. Although wine does not contain serious bacterial toxins, it may show trace amounts of fungal toxins (mycotoxins), generally produced by spoilage fungi that can grow on grapes before or after harvest. The latest to attract interest, ochratoxin A, is under active investigation in many wine regions. Although more common in red wines than in whites, and in wines from warmer regions, current data suggest that ochratoxin A does not constitute a health risk in wine. So, after a flurry of attention, it too may fade from consumer consciousness, as have aflatoxin and trichothecins.

TCA NOT THE ONLY CULPRIT IN THE DOCK

Ever since Dr Tanner first identified TCA (2,4,6-trichloroanisole) as an important source of mouldy (corky) odours in wine, it has been generally viewed as the principal causal agent of such odours. Recently, though, questions as to its importance have arisen. In last year's *Wine Report*, I noted research conducted by Dr Soleas on some 2,400 wines. TCA was present in sensory-significant levels in only about half of the wines identified with a corky taint. This clearly indicated that some other compound(s) were involved. To this end, Dr Chatonnet has provided an additional known musty-smelling compound to the long list of corky off-odours found in wine. The compound is a variant of TCA, with bromine atoms replacing the chlorine atoms on the anisole molecule – producing 2,4,6-tribromoanisole (TBA). It presumably is recognized by odour receptors in the nose as if it were TCA, consequently producing a similar smell. TBA can be derived from microbial methylation of the common flame retardant tribromophenol, which is found as a contaminant in some wooden, plastic, and cement structures.

Other compounds known to generate mouldy odours in wine include TeCA (another variant of TCA, with an extra chlorine atom), pentachloronitrobenzene (PCNB, a related compound used as a pesticide), and chloropyrazines, plus chemically unrelated compounds such as quaiacol, 3-methyl-1-butanol,

and 1-octanol (largely products of fungal growth), as well as sesquiterpenes such as geosmin and 2-methylisoborneol (produced by bacteria). With such a diversity in compounds producing mouldy odours, what is (are) the principal cause(s) of corky odours?

There are numerous critical problems in answering this question. What do people exactly mean when they say, "The wine smells corky"? Even most professional tasters are not trained to distinguish among the different chemicals known to generate 'corky' odours in wine. They are also unlikely to all have similar threshold levels for detection. Even if they do, my own training sessions with the Manitoba Liquor Control Commission clearly demonstrate that asking tasters to look for faults dramatically increases the number detected. It may be only when electronic noses (instruments that simulate the action of the nose) are used in such studies that we will finally begin to determine the relative importance of these compounds to corky odour production in wine. Then, hopefully, we can begin effectively to eliminate their presence in wine.

SEEING IS BELIEVING

In *Wine Report 2004*, I commented on the disconcerting evidence that what tasters see often markedly biases what they detect. This conflicts with the general view that experts sample wines objectively. The level to which visual information biases perception seems to depend on the apparent veracity of the information available (for example the wine's colour or

label) and the degree of conflict with the wine's taste and smell.

In recent studies conducted by Parr in New Zealand, wine experts' opinions were less influenced than those of novice tasters by adjusted sample colour. The wines' odour and taste characteristics clashed strikingly with clues given by their adjusted colour, at least for the experts.

In a separate study by Delwiche in the US, novice tasters were asked to taste and describe three samples of white wine, two of which had been doctored to appear as a rosé or red wine. The comments on the samples corresponded with the general impressions people have about the taste and flavour characteristics of white, rosé, and red wines, which indicates that established connections between colour and flavour expectations easily override sensory perception.

The moral of the story is that, if one wants an unbiased assessment, it is essential that tasters really taste

blind – they must not see the wine's colour. In addition, no information about the wine's origin or type should be available. In this way, only the wine's flavour can affect judgment.

YELLOW-ORANGE, THE NEW RED?

Researchers have always felt uneasy about the explanation given for the colour of red wine. The methods used have required assumptions that often were not verifiable. Recent studies have shown that this disquiet is partially justified. Not that anyone is claiming final victory, but we now understand wine colour a little more clearly.

Tannin-like compounds, called anthocyanins, have long been known to be the principal pigments in young red wine. As a wine ages, free anthocyanins oxidize or combine with themselves and other compounds to form the stable tawny pigments that characterize aged red wines. One of the benefits

Grapevine

- **Fraud is rarely detected** as a result of consumer complaint. Thankfully, chemists are continuing to add to their arsenal of authentication techniques. These analytical procedures can ferret out almost any form of fraudulent activity that could jeopardize wine quality or trueness of character. In a recent study of sparkling wines, Francioli and co-workers discovered chemical indicators of age (vitispirane, TDN, and diethyl succinate), making it possible to verify chemically whether higher-priced champagnes have indeed been aged on yeast as long as stipulated.

- **Eglinton and Henschke** have demonstrated that *Saccharomyces bayanus* may be better suited to producing flavourful wines than *Saccharomyces cerevisiae* (traditional wine yeast). The researchers found that the colour intensity of Shiraz and Cabernet wines improved with the use of *Saccharomyces bayanus*. The wines also showed more orange-peel, apricot, honey, and nutty flavours and were less estery in character than versions made with *Saccharomyces cerevisiae*.

of slight oxidation during in-barrel ageing is the production of a certain amount of acetaldehyde, which activates stabilization of the wine's colour. Most stable anthocyanin complexes have been thought to form in association with tannins. Not only do these complexes protect the anthocyanin chromophore (part of the anthocyanin molecule that generates colour), but they also increase colour depth and reduce colour loss – by enhancing solubility, precipitation is limited. Because anthocyanin-tannin complexes are known to possess yellowish, orange, reddish-brown to tawny colours, they were assumed to be largely instrumental in generating the aged colour of red wines. Most of these complexes are large polymers. It was surprising, therefore, to learn that a

new set of modified anthocyanins, of small molecular size, may significantly contribute to the colour shift in red wines. These are yellow-orange xanthylum compounds. Their study may shed new and practical information on the nature of red-wine colour.

ARE YOUR GLASSES IN GOOD SHAPE?

The effect of glass shape on perception has spawned the production of wine glasses in a cornucopia of shapes – some supposedly accentuating the properties of a particular wine type. Scientists such as Delwiche and Cliff have been investigating the significance of glass shape to a wine's characteristics. This has

required devising means of ensuring that tasters neither see nor feel the glasses involved.

As you might expect, shape does affect the intensity of the wine's fragrance – those possessing a wide base and narrow neck enhance the perception of the wine's aroma. However, the differences detected from a variation of shapes on the wide–narrow theme were marginal. Published evidence does not support the view that particular shapes uniquely enhance the character of specific wines. The one exception may involve flutes for sparkling wines, which facilitate observation of the bubbles. Whether they enhance flavour detection has not been studied. Incidentally, the ISO wine-tasting glass proved fully adequate to tasting both red and

white wines. The ISO glass also enhanced colour perception by maximizing wine depth relative to wine volume.

That particular shapes are not uniquely suited for tasting particular wines does not mean that they do not affect perception or, indeed, aesthetic pleasure. Science has amply confirmed that visual and psychological influences often have a greater effect on what we perceive than the more subtle sensory data provided by taste and smell.

STABLE PROTEINS ENHANCE WINE TEXTURE

Many wines, especially reds, are rough in their youth. During maturation, they can lose their

Grapevine

- **Screwcaps might be the only way** to keep *rosé* wines in the pink. A new role for anthocyanins has been discovered in *rosé* wines made from Cabernet Sauvignon. Like all *rosés*, they do not age well, losing colour and fragrance within a few years. Tominaga and co-workers in Bordeaux have found that anthocyanins limit the loss of an important aroma compound, 3-mercaptohexan-1-ol, which is critical to the fruity character of the wine. The protection provided by anthocyanins is suspected to result from their antioxidant properties. Regrettably, though, this oxygen-absorbing action also results in the early loss of the *rosé* colour – turning the wines orange. Since *rosé* wines do not contain sufficient other oxidizable phenolics to protect anthocyanins from oxidative browning, the obvious solution would be the use of screwcaps.

- **Always the poor cousin**, *rosé* has been viewed as possessing few of the qualities of red or white wine, yet exhibiting the failings of both. These deficiencies could be rectified, according to new research being conducted by Salinas and co-workers in Spain. Leaving the juice on the seeds and skins under cool conditions prior to fermentation increases fruit flavours and varietal aroma. In addition, supplying pectolytic enzymes to the juice–seed–skin mixture enhances colour stability – a major problem with all *rosés*. Enzyme treatment also improves the fresh, fruity character of the wine. Such techniques may herald a new era for *rosés*.

Grapevine

- **Bespoke sensors** are being developed to determine whether wines are oxidized without having to open any bottles. Work by Skouroumounis and co-workers should provide wineries and large retailers with a means to determine whether bottled wine has become too oxidized by passing light through the bottle to measure the wine's absorbance. Nuclear Magnetic Resonance (NMR) is also being investigated for the automatic assessment of acetic acid levels.

- **Silva Ferreira and co-workers** in Portugal have observed that, as tawny ports age, there is a slow, progressive accumulation of sotolon. This is intriguing because the importance of this compound is already established in the flavour of botrytized sweet wines (such as ausleses and sauternes) and sherry and sherry-like wines (such as Château-Chalon).

- **Oxidized white wine** is associated with the sharp, penetrating, nutty odour of acetaldehyde, which is natural, since the primary aromatic compound first produced on oxidation is acetaldehyde. With time, though, acetaldehyde reacts with other compounds and its contribution to the final off-odour of oxidized wine declines. Slowly, the oxidized character takes on honey, hay, and wood-like nuances. Several of the compounds involved are also aldehydes. Silva Ferreira and co-workers have just shown that one of the most aromatically important is a sulphur-containing aldehyde – 3-(methylthio)propionaldehyde. Others involved are phenylacetaldehyde, TDN (1,1,6-trimethyl-1,2-dihydronaphthalene), and sotolon (4,5-dimethyl-3-hydroxy-2(5H)-furanone).

harshness and taste smoother. This has usually been explained as the progressive association of smaller, more bitter-tasting tannins into large complexes. These tend to be less bitter and eventually may precipitate (forming sediment in the bottle), leaving the wine with a refined mouth-feel sensation.

New factors in this ageing process may be the ill-studied, stable, soluble proteins in wine. Most of these proteins come from the juice of crushed grapes. Fukui in Japan believes that their reaction with tannins and tannin-polysaccharide complexes decreases their ability to react with taste receptors in the mouth. If this role is confirmed, the stable proteins in wine (that is, those not involved with haze production) may provide winemakers with a new measure of how well a wine will age. It may also supply an additional means of regulating wine quality.

ICEWINE INVESTIGATION

The scientific understanding of icewine production is still in its infancy. One of its fascinating aspects relates to how yeasts survive and ferment in the viscous, syrupy juice extracted from frozen grapes. Inglis and co-workers have started to unravel the mystery. The yeast increases its production of enzymes that convert acetaldehyde (produced during sugar fermentation) to acetic acid, rather than the more frequent change into alcohol. In the process, energy is generated that can be used to increase the

production of glycerol. Glycerol helps limit water loss from yeast cytoplasm (essential for growth and metabolism) in the highly osmotic juice. Inglis is also investigating how best to inoculate the juice with yeasts to achieve adequate alcohol production. Reaching the desired 12 to 14 per cent alcohol content is a frequent problem for producers.

STICKING POINTS

In an ideal world, the sugars from crushed grapes would ferment easily. In the real world, fermentation may occur slowly or stop altogether before completing the conversion of grape sugars into alcohol. Many researchers have looked into fermentative failure and have discovered a number of causes: fermentation temperatures being too high or too low; insufficient nitrogen; osmotic effects of high sugar content; insufficient oxygen to produce essential cellular components; toxic fermentation byproducts; and 'killer' factors that destroy yeast cells.

Sablayrolle in France is approaching the problem in a different way. He has started to divide incomplete fermentations into separable and definable categories, each characterized by its own dynamics. Two categories have been differentiated so far – vinifications with slow fermentation rates and fermentations coming quickly to a premature stop. Separating incomplete fermentations into distinguishable groups may facilitate the development of strategies to reverse their damaging effects.

RED WINES LIKE IT COLD

Maceration, the technique of leaving juice in contact with seeds and skins after grape crushing, has become standard practice in the production of many white wines. It usually lasts 6–24 hours at cool temperatures and is followed by pressing, which liberates the juice, then by fermentation. With red wines, maceration normally occurs simultaneously with fermentation, lasting several days to weeks. However, a cold, pre-fermentative maceration period for red wines is almost unheard of. If it occurred, it was unintentional and the result of delayed barrel fermentation in cold, unheated cellars.

Recently, however, several researchers have shown the benefits of cold maceration for some red wines. Its utility was first demonstrated for the delicate variety Pinot Noir, where it improved colour and flavour extraction. Nevertheless, cold maceration can also benefit more flavourful and fully coloured varieties, such as Shiraz and Cabernet. Marais has now extended these findings to Pinotage. Whether this heralds a new trend in red winemaking, where cool pre-fermentative maceration becomes a norm, is too soon to tell. In the increasingly competitive world of wine, any practice that promises to distinguish a wine from its competitors will soon be extensively tested worldwide.

HEAT ZAPS HAZE

Consumers take wine clarity for granted. This is not the case for winemakers, who spend time and

money producing crystal-clear wines. Unavoidably, a lot of wine is lost in the process. It is estimated that protecting wine from protein-induced haze results in the loss of A\$50 million worth of wine in Australia alone, as wine is discarded with the bentonite used to remove haze-producing proteins. On a world scale, the economic losses associated with attaining wine clarity are staggering. Any procedure that could reduce this wastage would indeed be welcome. Such a solution may be on the horizon.

Waters and co-workers in Australia have demonstrated the economic value of the combined action of a very short high-temperature treatment with protein-degrading enzymes. The heat favours the rapid degradative action of the enzymes. By destroying haze-generating proteins, the amount of bentonite (or other fining agents) needed to achieve protein stability is greatly reduced. Correspondingly, much wine can be saved. The process has no adverse sensory effect on the wine.

HOW TO AVOID FERMENTING TROUBLE

Different species and strains of yeast and lactic acid bacteria can give wine a distinctive 'signature'. Strain selection is a powerful tool when making wines with a distinctive character, and the number of strains now available is bewildering. However, some yeast strains may selectively inhibit the action of particular bacterial strains used to induce malolactic, and this may not always be desirable. Henschke and co-workers have simplified the choice by developing a standardized

laboratory method for testing compatibility between yeast and bacterial strains. Once a winemaker has made his or her selection of a strain or strains of yeast, the test should indicate whether the chosen bacterial strain can successfully complete malolactic fermentation.

TRUFFLE AROMAS ARE SULPHUR FAULTS

Most reduced-sulphur compounds possess repulsive, putrid odours, with apt descriptive terms that include "rotten eggs", "barnyard", and "skunky". However, recent studies show that certain assumed varietal aromas are due to related compounds, and this has raised eyebrows. The latest in the salvo of findings comes from the lab of Tominaga in Bordeaux. He has highlighted the importance of benzenemethanethiol to the aroma of Sauvignon Blanc, Semillon, and Chardonnay wines and has also discovered its significance in the aged character of champagne. The compound donates a smoky (toasty?) empreumatic fragrance. Another

significant sulphide is dimethyl sulphide. De Pinho has associated an increasing presence of this compound with the aged character (for example, quince and truffle) of ports.

GOÛT DE LUMIÈRE

Several years ago, Maujean spearheaded research on champagne off-odours induced by exposure to light. Several reduced-sulphur compounds were identified as the causal agents of what they called *goût de lumière*. The issue has recently been reinvestigated by D'Auria and co-workers in Italy. Surprisingly, they have not confirmed the presence of the compounds found by Maujean, such as hydrogen sulphide, methyl mercaptan, and dimethyl sulphide. Instead, they detected an increased presence of 2-methylpropanol (higher alcohol) and a significant modification as well as reduction in the presence of many fruit esters. This raises the question of whether the light-induced off-odours in champagne identified by these respective researchers are identical or not (despite a common name).