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"Influence of sulfur dioxide on the formation of aldehydes in white wine"

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Does SO_2 change the chemical/flavor profile of a wine? The answer is yes. As this paper shows, SO_2 affects the aldehydes that are formed during fermentation, which in turn, affect flavor. Up to now, aldehydes were very difficult to measure, but with the method that the authors develop here, they are able not only to measure them but to distinguish between the different types.

• Al-de-hydes (which derive their name from the fact that they are **al**cohols that have been **de-hyd**rogenated) are byproducts of fermentations that contribute to a wine's flavor. Besides their role 1) in **flavor**, aldehydes also play a role 2) in **color**, by reacting with sulfites and preventing bleaching, and more importantly, by participating in the binding of anthocyanins to tannins and stabilizing color. Finally, aldehydes also play a role 3) in **texture**, due to the above participation in tannin polymerization reactions.

• The different aldehydes are named after the amount of carbons in their chains (from 1 to 9 carbons: formaldehyde, acetaldehyde, propanal, butanal, pentanal, hexanal, heptanal, octanal, and nonanal). Acetaldehyde (2 carbons) is the aldehyde we are probably most familiar with. This is because when acetaldehyde gains back its hydrogen (or is oxidized), it forms ethanol. The other reason why acetaldehyde is so familiar is its unmistakable smell: cut apples, sherry and nuts.

• Several factors can affect the production of aldehydes: yeast strain, temperature, pH, O_2 level, SO_2 level, and nutrient availability. Of these, SO_2 is particularly important because SO_2 affects the enzyme that converts acetaldehyde into ethanol (aldehyde dehydrogenase). SO_2 also binds directly with acetaldehyde, preventing its transformation into alcohol.

• Up to now we knew very little about the effect of SO_2 on aldehyde production and wine flavor because of the limitations of the analytical methods available. In this study, the authors were able to turn aldehydes, which are very unstable, into more stable compounds by making them react with amines (giving rise to compounds called *thiazolidines*). After extraction with chloroform, the different aldehydes –now converted to thiazolidines – could be separated and quantified by gas chromatography.

• **Fermentations**. A juice concentrate (Thompsom Seedless and French Colombard mix) was brought to 23^{o}Brix with water, nutrient enriched (diammonium phosphate) and yeast inoculated (Premier Cuvee). The 5-gallons containers were then treated with 0, 50, 100, 150, and 200 mg/l SO_2. Fermentations, in duplicate, were monitored by weight loss (CO_2 evolution). The authors took a sample from each fermentation approximately every 4 hours, to determine the aldehyde formation with time for each SO_2 level.

• **Results**. Three types of **aldehydes** (acetaldehyde, methyl-propanal and methyl-butanal) were formed early in the fermentation, and most were affected by the presence of SO_2, **increasing as SO_2 levels increased**. Of the three, acetaldehyde was the one most affected by SO_2. In contrast, the aldehyde types that were formed towards the end of the fermentations (formaldehyde, propanal, pentanal, hexanal, and heptanal) were not sensitive to the level of SO_2. The larger aldehyde types (octanal and nonanal) were practically undetectable in this study. Obviously, those aldehydes that are produced, but are also readily lost during fermentation through volatilization, would not be measured with this technique.

• An interesting result was that the four fermentations with the lower SO_2 levels (0, 50, 100, and 150 mg/l SO_2) followed a similar pattern of aldehyde accumulation (a maximum after an initial lag phase, then a gradual decrease). In contrast, the fermentations with the highest SO2 level (200 mg/l) resulted in a very different pattern (much higher aldehyde levels that persisted longer). The authors attribute this to the fact that, for the lower SO_2 levels, all the free SO_2 is eventually bound to other compounds, resulting in less effect on the aldehydes. With the high SO_2 treatment, on the other hand, there is excess free SO_2 throughout the fermentation, so its effect on aldehyde formation would be likely to persist longer.

In summary, the authors were able to optimize an analytical technique to accurately distinguish and measure the different types of aldehydes present in wine, something not possible up to now. They found that, the higher the SO_2 dosage used, the higher the final level of acetaldehyde. Specific aldehydes which impart specific aromas can now be monitored with this tool, and SO_2 levels can potentially be adjusted -within limits- to optimize the production of those aromas that are most desired. Obviously, more sensory studies are needed to establish the relationship between each aldehyde and its effect on a wine's sensory properties. Understanding the factors that influence aldehyde production is critical for producing wines with desired sensory and chemical properties.

Aldehyde	**Flavor characteristic**
Formaldehyde (C1)	Sharp, pungent
Acetaldehyde (C2)	Cut apple, nutty, sherry
Propanal (C3)	Cut apple, nutty, sherry
Methyl-propanal (C4)	Apple-like
Butanal (C4)	Pungent
Methyl-butanal (C5)	Herbaceous, nutty, acrid (high conc.)
Pentanal (C5)	Nutty, pungent (high conc.)
Hexanal (C6)	Grassy, fruity
Heptanal (C7)	Fatty, unpleasant
Octanal (C8)	Sharp, fatty, fruity
Nonanal (C9)	Fatty, orange/rose, citrus

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