



# Indole off-flavour in sparkling wine

In recent years, the AWRI helpdesk has received queries from a number of companies about indole off-flavours developing during the secondary fermentation of some tank-fermented sparkling wines. In this column, Geoff Cowey draws on general information and data obtained from a 2019 trial to answer some questions about indole.

## What is indole?

Indole is an aromatic heterocyclic organic compound involved in amino acid biosynthesis in plants and fungi that has also been linked to a 'plastic'-like off-flavour in wines produced under sluggish fermentation conditions and, more recently, in tank-fermented sparkling wines. Indole has not been observed in traditional method sparkling wines or sparkling red wine and the causes of the indole problems in tank-fermented sparkling wines were unknown. To investigate this issue, a trial was conducted in 2019, with fifty-four tank sparkling wine fermentations from several producers examined over a six-month period, analysing the base wines as well as the finished sparkling wines. The aim was to investigate the key drivers behind indole formation and to identify ways for sparkling winemakers to prevent it occurring.

## What does indole smell like?

The aroma of indole is described as having floral notes such as 'white flowers', 'jonquil' and 'jasmine' at low concentrations but an unpleasant 'chemical', 'plastic', 'mothball', 'styrene'

and 'rubber/plastic' aroma at higher concentrations. Wines seen to be affected by an indole off-flavour have been observed with concentrations between 30 and 350 µg/L. The aroma detection threshold of indole is 23 µg/L; however, there is wide variation in sensitivity between individuals and some people are unable to detect the character at all.

## Is indole in wine derived from the grape?

In grapevines shikimic acid is used as a building block to produce a range of amino acids including tryptophan. Indole is an intermediate compound in tryptophan production, which also requires serine and pyridoxine (Vitamin B6) substrates, and indole does not normally accumulate in plants during this process. As indole was not observed in the sparkling base wines examined in the 2019 trial, and was only detected in the corresponding tank-fermented sparkling wine, this suggests the indole was not grape-derived (i.e. it was not being produced from a breakdown in the tryptophan biosynthesis in the grapevine).

## Is indole produced during fermentation?

Tryptophan is considered a grape-derived, limited amino acid in grape juice and wine, and can be used as a nitrogen source by yeast during wine fermentation. Yeasts can produce tryptophan using a pathway similar to that of plants, using serine and pyridoxine as precursors. Analysis of base wines found that concentrations of serine and pyridoxine were similar whether or not higher concentrations of indole were produced during secondary fermentation, suggesting that these analytes were not rate-limiting drivers of indole formation/accumulation.

## Is indole produced by bacterial spoilage of yeast propagation cultures?

Some bacterial species possess a tryptophanase enzyme that can break down tryptophan to produce indole in wine. However, bacteria were not detected in the yeast culture preparations used in the secondary tank fermentations that resulted in indole-affected sparkling wines. This suggests that indole formation is unlikely to be due to bacterial spoilage

in cultures and instead points toward indole production occurring via a yeast-mediated metabolic pathway.

### Is indole produced from a yeast-related breakdown product?

Tryptophan can be metabolised by yeast to indole-related compounds such as indole-3-ethanol (tryptophol) and indole-3-acetic acid (IAA). These can react further during stressful conditions in alcoholic fermentations, possibly such as those of sparkling wine fermentations, to produce aminoacetophenone (AAP) and 3-methyl indole (skatole). These volatiles have been implicated in other sensory defects known as 'atypical' ageing character. Compared to the base wines in the 2019 trial, the corresponding sparkling wines did not have elevated concentrations of tryptophol or IAA. This suggests that indole generated during sparkling fermentations is unlikely to be the result of tryptophan degradation. In addition, GC-olfactory analysis of indole-affected wines

showed no presence of AAP or skatole and confirmed indole to be primarily responsible for the sensory defect. Non-targeted metabolomic analysis also did not identify differences between ferments that generated indole and those that did not.

### What are the current theories on indole formation and its prevention and removal?

Results to date point towards indole production occurring in sparkling wine ferments via a failure of the penultimate step of the tryptophan synthesis pathway in yeast. Further research is required to challenge a base wine and yeast culture under different fermentation conditions to determine the key drivers for indole formation. One producer found an increased risk of indole formation when using rapid yeast culture scale-up procedures with no rest periods. Culture propagation scale-up over several days before intended use, including a culture rest day between each scale-up addition, is thus currently recommended.

There is no scientifically proven treatment to reduce indole concentration in affected wines in tank. Some producers have found refermenting the affected wine can metabolise the character. Four degradation trials performed by the AWRI helpdesk also showed that an indole concentration of around 100 µg/L degrades in bottle to below sensory threshold levels over a period of 6-12 months. It should be noted that holding a bottled sparkling wine for this length of time before sale could reduce the freshness of the wine style.

### Acknowledgement

The wine companies participating in these trials and multiple staff working across several teams at the AWRI are all thanked for their contribution towards this work.

For further information about indole or other technical winemaking or viticulture questions, contact the AWRI helpdesk on (08) 8313 6600 or [helpdesk@awri.com.au](mailto:helpdesk@awri.com.au) **GW**

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