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Origin of fresh mushroom off-flavor in wine

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Fresh mushroom flavor in wine is generally considered a fault. The fungus responsible for this organoleptic defect, *Crustomyces subabruptus*, has recently been isolated. The main compound involved is 1-octen-3-one, which is perceptible in white wines at concentrations above 40 ng/L.

Introduction

Fresh mushroom off-flavor is characterized by an odor typical of the common mushroom. It is sometimes accompanied by similar odors, such as undergrowth or humus, but without vegetal or moldy notes. This odor is unacceptable in dry wines and sparkling wines. In high-alcohol wines it may blend in with the underlying aromatic complexity. Undergrowth aroma is one of the typical descriptors of some Pinot Gris wines from Alsace. The problem appeared in Alsace in the 1990s. It strongly impacted the 2006 vintage due to the particularly unfavorable climatic conditions that year[1]. It has also been found in Champagne since 2005, with variable intensity depending on the vintage[2]. There is no relation between the level of *botrytis* bunch rot and the incidence of fresh mushroom off-flavor. Grape varieties with compact bunches, such as Pinot Gris in Alsace or Pinot Meunier and Pinot Noir in Champagne, are particularly sensitive. Contaminated bunches have a mushroom odor but, unlike moldy-earthy flavors linked to the presence of geosmin, fresh mushroom off-flavor is imperceptible in musts. It is possible that 1-octen-3-one combines to form an odorless compound and is present as a precursor. The defect reappears after the alcoholic fermentation or after the first sulfite addition[3].

Compounds responsible

Several compounds have a fresh mushroom odor. Three of them have been identified in affected wines. 1-octen-3-ol has a perception threshold of approximately 40 µg/L in white wine. The concentrations measured in faulty wines rarely exceed this value. It does not contribute to the fault. The two other compounds, 1-octen-3-one and 1-nonen-3-one, have a much lower perception threshold (40 ng/L and 20 ng/L respectively in white wine) and can be found in wine at concentrations above these values. The former is found much more frequently, however, and it has been shown that the intensity of fresh mushroom off-flavor is correlated to the 1-octen-3-one concentration in the wine[3]. These compounds are quite widespread in fungi. They have also been isolated from many food products. They are formed by enzymatic or oxidative degradation of lipids.

Microorganism responsible

A basidiomycete capable of producing large quantities of 1-octen-3-one has been isolated from grapes with fresh mushroom off-flavor in work carried out by the IFV, CIVA and CIVC[4]. This is a wood-decay fungus, *Crustomyces subabruptus (Bourdot & Galzin) Jülich 1978*, which is quite common in temperate regions. This is the first time it has been reported in the vine. It is a corticoid fungus, i.e. it takes the form of a spreading crust and has no gills. It has been identified as saprotrophic on conifer and angiosperm wood but also as an endophyte, i.e. present in the plant without causing apparent disease, in *Ferula* species in China. Our observations show that it may also be an endophyte of the vine. Under favorable conditions, it grows inside *botrytis*-affected bunches (Figure 1) giving off a fresh mushroom aroma of greater intensity with increasing relative humidity. Juice from Pinot Gris bunches infected with the fungus and kept at various levels of relative humidity can contain 1-octen-3-one at concentrations in the order of a few tens of micrograms (Figure 2). Hence, it only takes a few affected bunches to infect the entire crop from a plot.



FIGURE 1. Pinot Gris with botrytis bunch rot and the white mycelium of *C. subabruptus* – Photo IFV.

Formation of the defect in wine

The appearance of the defect in wine cannot be explained by a simple passage from grape to must and from must to wine, as is the case with geosmin and the resulting moldy-earthy flavors. The defect is perceptible in grapes but not in the must after pressing, even when 1-octen-3-one concentrations are very high. It is probably adsorbed by other compounds, making it undetectable by smell. During the alcoholic fermentation, some of the 1-octen-3-one is broken down by the yeasts[5]. Nevertheless, after spiking with infected musts, it was possible to measure 1-octen-3-one concentrations in the wine after fermentation that were higher than the quantities added. It is therefore highly probable that precursors of the compound are present in musts. The defect becomes obvious after alcoholic fermentation or on the first sulfite addition. Its intensity fluctuates as aging progresses.

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Redox conditions seem to have an influence on the appearance or perception of the defect.

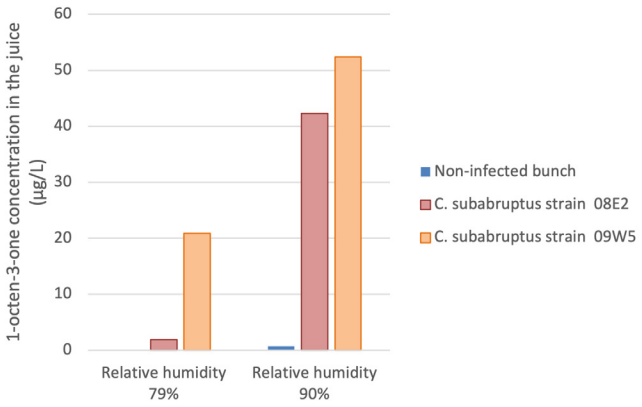


FIGURE 2. Influence of relative humidity on the production of 1-octen-3-one in bunches infected with *C. subabruptus*.

Preventive measures

When the harvest is affected by *botrytis* bunch rot, rigorous clarification of the must, to a turbidity of around 50 NTU, can limit the consequences for wine quality. Use of fining agents can reduce the olfactory defect but is accompanied by a loss of structure on the palate[6]. In the event of a marked moldy-earthy defect, treatment of the must with activated carbon may prove to be a necessary evil[7]. For fresh mushroom off-flavor, the absence of the defect in the must makes it impossible to identify suspect batches in the cellar and apply a specific treatment. Treatment of wine is ineffective or too harsh.

Spraying in the vineyard is of no use, as the fungus is an endophyte. Preventive measures, such as reducing canopy density or bunch compactness, reduce the risk of fresh mushroom off-flavor as well as attack by *Botrytis*[8]. At harvest, affected bunches should be rigorously eliminated. They are characterized by the presence of *Botrytis* accompanied by a white mycelium, usually at the center of the bunch, and a mushroom odor. ■

Sources *Sourced from the research article "A Basidiomycete Fungus Responsible for Fresh Mushroom Off-Flavour in Wines: Crustomyces subabruptus, (Bourdot & Galzin) Jülich 1978." (OENO One, 2021).*

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