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Wine closure types found to shape chemical and sensory evolution of red wines during storage

Study reveals natural cork, micro-agglomerated cork, and screw caps each create distinct bottle environments affecting wine aroma and flavor development

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A recent study conducted by researchers from the University of Aveiro in Portugal, in collaboration with MA Silva, a leading cork producer, has provided new insights into how wine closures impact the evolution of red wine during storage. The research focused on understanding the chemical and sensory changes that occur in wine when sealed with different types of closures over short and medium storage periods, specifically 5 and 35 months.

The study examined red wines from two regions: Burgenland in Austria and the Douro Denomination of Origin in Portugal. Wines were bottled using natural cork, various micro-agglomerated corks, and screw caps with tin liners. The bottles were stored horizontally to simulate typical cellar conditions. Researchers used advanced analytical techniques, including gas chromatography-mass spectrometry and ultra-high-performance liquid chromatography, to monitor volatile compounds, phenolic profiles, color parameters, sulfur dioxide levels, acidity, and pH. Sensory analysis was also performed by a panel of experts to assess how the closures influenced the wines' aromas and flavors.

One of the main findings was that the type of closure significantly affects the rate at which oxygen enters the bottle. This oxygen transfer rate (OTR) is a key factor in how wine evolves after bottling. Natural corks allowed more oxygen ingress compared to screw caps, which created a more reductive environment inside the bottle. Micro-agglomerated corks showed intermediate behavior depending on their specific composition.

In Douro red blends, wines sealed with natural cork were perceived as more oxidized in retronasal sensory analysis than those closed with micro-agglomerated corks. However, no significant differences were found in orthonasal aroma perception. Cluster analysis based on volatile composition and combined data domains confirmed clear distinctions between wines sealed with different closures.

For Burgenland red blends, significant differences were observed between wines sealed with screw caps and those with micro-agglomerated corks in retronasal analysis. Again, orthonasal differences were not statistically significant. The screw cap-sealed wines stood out as being most distinct from others, especially for short-term storage. Volatile

composition proved to be a sensitive indicator for detecting closure-induced changes during this period.

The study also found that screw cap closures tended to create more reductive conditions inside the bottle. This was evidenced by slightly higher levels of sulfur-containing compounds associated with reduction faults and lower antioxidant activity compared to wines sealed with natural corks. In contrast, natural cork closures promoted moderate oxidation processes that led to increased formation of certain aromatic compounds such as norisoprenoids and esters, which can enhance floral and fruity notes in wine.

These oxidative reactions were more pronounced as storage time increased. The research highlighted that each closure type creates a unique microenvironment within the bottle, influencing both chemical evolution and sensory characteristics of the wine over time.

The findings suggest that winemakers should carefully consider closure selection based on the style of wine and intended shelf life. For wines meant to develop complex aromas over time, natural cork may be preferable due to its controlled oxygen ingress. For wines intended for early consumption or where preservation of primary fruit character is desired, screw caps or specific micro-agglomerated corks may offer advantages.

This research was supported by funding from FCT/MEC and MA Silva under a service contract with the University of Aveiro. The results contribute valuable knowledge for both producers and consumers about how closure choice can shape wine quality during storage. Further details about this study are available through MA Silva’s website and in the journal Foods (2025).