

TRACEABILITY ALONG THE WINE PRODUCTION CHAIN

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Ensuring the authenticity of wine has been a difficult issue for the authorities for a very long time, because wine has an aqueous matrix, making it relatively easy to counterfeit. In Roman times, and later in the Middle Ages, "lead sugar" (lead acetate) was used as a sweetener, but even in recent times some winemakers added ethylene glycol to increase the sweetish taste of wines.

Modern consumers demand urgent assurances on the quality, safety and security of wine, even if its constituents are already strictly regulated by international organisations (OIV) or government agencies.

In this light, to avoid fraud and health risks, the traceability of wines should allow consumers to verify the origin and composition of each individual batch of wine, including the grape-growing area, transformation plants, all the chemical products that have been in contact with wine along the whole wine supply chain and storage conditions. The "ability to trace the history, application or location of an entity by means of recorded identifications" (ISO 8402) is one of the most internationally accepted definitions of traceability, along with the General Food Law - Council Regulation (EC) No. 178/2002 and the Codex Alimentarius Commission.

By recording the origin of all chemical products and monitoring the entire wine production chain it is possible to support public control bodies during their certification activities, in order to verify whether the final products actually have the quality characteristics claimed and the link with the declared geographical origin.

Many other factors, depending for instance on climate and soil, can influence vine growth, with a direct influence on the chemical composition and sensory perception of wines. The concept of "terroir" was first introduced in Europe, considering the specific characteristics of wine resulting mainly from the environmental conditions in which grapes are grown, and the production characteristics in the area concerned. Wines characterised by remarkable quality features produced within specific traditional geographic areas can be legally assigned designations of controlled origin (e.g. DOC, DOCG, AOC, VDQS, QmP, QbA, etc.).

Wine authentication aims to confirm all the declarations on the label, which are linked to the consumer's expectations as regards the sensory characteristics and quality of products. Wine controls, traditionally focused on proof of authenticity, investigate the chemical composition extensively, using various analytical methods to detect fraudulent statements on wine labels, in relation to aspects such as origin, vintage and the variety used .

The volatile compound profile has been used to identify the geographical origin of wines produced in different European Countries, and between European and American products. The mineral profile was shown to be one of the most effective ways of assessing the geographical origin of wines, but depends on the heavy impact of technological processes on the mineral macro-component composition of wines. Recently, attention has been focused more closely on elements that, while sometimes very rare, are only marginally changed during winemaking. Mineral profile analysis has also been suggested for identification of wine variety, due to the

selective ability of different vines to accumulate certain elements. Wine geographical origin authentication was also effectively pursued through determination of the stable isotopic ratios (D/H, $^{18}\text{O}/^{16}\text{O}$, $^{13}\text{C}/^{12}\text{C}$) of the water and alcohol of wine, variations in which are caused mainly by climatic or botanical factors.

Likewise, varietal authentication of grapes has been performed on the basis of amino acid and protein profiles, although they are subject to microbiological transformation and technical stabilisation. Anthocyanin profiles have been extensively investigated for red wines, and characteristic acyl/coumaryl ratios have been proposed for some varieties, assuming that these bound compounds are preserved during grape processing and wine ageing. However, the hydrolysis occurring to flavonol 3-O-glycosides limits the application of flavonol profiles to varietal wine discrimination, even when it is possible in the corresponding grapes. Shikimic acid content showed promising applications, in particular to Pinot wine authentication, and is often used as a general interesting indicator of wine authenticity. It is also worth noting the possibility of varietal characterisation of wines using aroma profiling, in particular when they are produced using aromatic cultivars.

Finally, the application of new analytical tools based on metabolite profiling and sophisticated molecular biology analysis now offers new opportunities to meet the challenges in terms of wine safety, quality and traceability studies.