

The influence of climate variability on chemical composition of European wines: a regional scale study (Italy and Slovenia)

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Climate change is having an increasing influence on vine phenology and grape composition, affecting vinifications, wine chemistry and the quality of productions.

Wine grape cultivation provides a good test case for measuring indirect impacts mediated by changes in agriculture, because viticulture is sensitive to climate and is concentrated in Mediterranean climate regions that are global biodiversity hotspots. Moreover, on a regional level and on a shorter time scale, the seasonal weather conditions modify the quality of yields determining the final properties of wine.

In the present research, we studied wines from Italy and Slovenia with the purpose of differentiating them by the different vintages (from 2009 to 2012), which are supposed to be influenced by temperature and rain during each year's growing season. Specific chemical techniques were used, in particular mass spectrometry (ICP-MS) and isotopic mass spectrometry (IRMS), both of which are usually employed to detect wine adulterations and to establish the geographical provenance of wines.

In particular, we investigated the relationship between macro- and micro-elements, Rare Earth Elements and stable isotopes [$\delta^{13}\text{C}$, $\delta^{18}\text{O}$, (D/H)I, (D/H)II].

The datasets were examined via statistical techniques to show their relation to weather conditions as well as their mutual connection.

Italian and Slovenian wines were distinguished, with the exception of few samples, by both TEs and REEs results. This separation, due to different elemental compositions, may be justified as being part of two distinct environmental and geographical belongings (terroir) but also to the processes of wine production, from the harvest to the bottling, which have certainly interfered and characterized the products.

In the case of Italian wines the weather conditions were evidenced with an important separation of stable isotopes which they confirmed to be very sensitive

Regarding Slovenian wines, the studied regions were characterized of three very different environments, and the elemental measurements resulted very useful. However, it was not possible to separate the different wine regions using elemental composition while the vintages were clearly evidenced.

The results of this work were not able to confirm the mass spectrometry and the isotopic mass spectrometry to be useful to distinguish a wine for a specific region while they were able to separate vintages growth in different weather conditions. In conclusion of the work we can furthermore suggest from our data that weather conditions showed to have more influence in the chemical composition of wines than the environmental contribution.

Moreover, the more is different a year in terms of weather conditions, the more the techniques of analysis can show the separation of the wines made in that year. However, has been not possible distinguish vintages produced in years of similar weather conditions.