THE DYNAMICS OF THE OXIDATION PROCESS OF WHITE WINES DEPENDING ON TEMPERATURE, MOLECULAR OXYGEN RATE AND PH

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Oxidation processes are slow phenomena that take place throughout the wine's life, from the beginning of winemaking to aging in bottles. Several parameters play an important role in aging of the wine, such as the temperature and hygrometry during the storage of the bottles but also the permeability of the corks which will influence the amount of oxygen brought to the wine. The impact of storage conditions on the evolution of wine was studied by comparing storage in optimal conditions (temperature between 15 and 17°C, relative humidity 70%) representing aging in the cellar, and aging reproducing the conditions of a house or apartment (temperature fluctuation between 20 and 27°C and humidity depending on the seasons). The results showed 3 times more fast aging for wines stored in conditions that reproduce an apartment, by comparison to aging in the cellar. The impact of storage temperature was also studied on sensory properties of Sauvignon blanc wine, three temperatures of storage (5, 10 and 18°C) being studied for one year. The wines stored in cooler conditions (5 and 10°C) were characterized by fruity aromas while the wines stored at higher temperatures were characterized by woody, buttery or of asparagus. White wines have a lower concentration of phenolic compounds than red wines (10 to 20 times less) and therefore a lower antioxidant capacity, are more susceptible to oxidation [1]. The amount of oxygen received by the wine is very dependent on the type of cork which defines the oxygen transfer rate. They can be classified by permeability to oxygen depletion with: synthetic plug > threaded cap > natural cork > plug microagglomerate.

Under normal conditions of pressure and temperature, the maximum solubility of oxygen is 8.6 mg/L, then it gradually reduces to the hydroperoxyl radical anion (O_2•-), oxygenated water (H_2O_2), to the hydroxyl radical (HO•) and finally to water (H_2O), producing species called “reactive oxygen species" (ROS). The fundamental electronic configuration of oxygen is the triplet state, so it can be considered as a diradical. The Pauli exclusion principle limits reactivity to oxygen. This is why oxygen must be "activated" to go into the singlet electronic configuration. In singlet form oxygen can reacts directly with carotenoids, olefins or polyphenols. In addition, from a thermodynamic point of view, the reaction between oxygen and phenolics such as catechin or caffeic acid is at a disadvantage, the redox potential of of O_2/H_2O_2 couples, catechin and caffeic acid with quinones respectively being 0.57, 0.58 and 0.60 V 25. Therefore, a catalysis is required to obtain the first oxygen reduction reaction (O_2 to HO_2•). In must enzymes oxidases will have this role and in the wine there will be mainly Fe^{2+} ions. The radical hydroperoxyl (HO_2•) can react directly with phenolic compounds in wine, as it is a stronger oxidant than oxygen with a redox potential of 1.23 V vs -0.09 V at pH 3.5. Hydrogen peroxide is formed by the reduction of HO_2•, which in the presence of iron leads to the Fenton reaction and the production of the hydroxyl radical. HO• will react non-selectively, due to its strong oxidizing power, forming the final product of reduction of oxygen, a water molecule.

Keywords: White wine, aging, oxygen, storage conditions, aromas.

References:

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