TEMPERATURE CONTROL IN WINEMAKING

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Extract from Technical Notes of Code of Best Practice for Organic Winemaking, produced under the EU FP6 STREP project ORWINE

Effect of Temperature on Must and Wine

How can temperature control help to avoid additives?
Temperature control during the wine-making process is very important for the final quality of the wine. Even if it cannot replace all functions it can complement the effect of sulphur dioxide (SO_2) at certain points.
Temperature influences the activity of enzymes, which are present at various points during the whole production process of wine. Enzymes are already present in the grape and may affect the aroma through **oxidation** and influence the **degradation of the grape mash** during maceration. They are also responsible for the **metabolic processes in the living micro- organisms**, such as bacteria, yeasts…and fungi. The most relevant species that are affected during wine-making are: acetic acid bacteria, lactic acid bacteria, yeasts and the fungus *Botrytis cinerea*. Their activity is always influenced by the temperature. Thus, the wine-maker has the option of controlling these factors by controlling the temperature. An increase in temperature accelerates enzymatic processes. In biological systems reactions do not run at 0°C. Above 0°C the reactions start slowly and finally reach a maximum at around 37°C. Temperatures over 37°C change the structure of enzymes and finally lead to the decrease and elimination of enzymatic activity. Thus, every enzymatic process has its optimum and the wine-maker can choose between delaying and enhancing the activity of certain micro-organisms by controlling the temperature.

Grape harvest:

When harvesting and crushing grapes, temperatures should be as low as possible in order to minimize the activity of fungus (e.g. *Botrytis cinerea, Trichothecium roseum)*, undesired bacteria (e.g. *Gluconobacter, Acetobacter*) and undesired yeast species (e.g. non-*Saccharomy-ces* yeasts), which can be present on the grapes. As soon as the grapes are injured, sugar is available for the metabolism of micro-organisms. It is at this point that the addition of sulphur dioxide has the effect of inhibiting the activity of micro-organisms and inhibiting the activity of enzymes. Temperature control is an effective tool to control these reactions. Temperature should be low during the whole process: picking of grapes, transport, crushing and maceration (if applied). Only by avoiding the multiplication of undesired fungus, bacteria and yeast on the grapes one can avoid the formation of volatile acids, toxins and/or ethanol in this early stage of wine production. Crushed grapes, exposed to sunlight and warm temperatures always lead to a loss in quality. Especially when grapes are injured or infected by fungus, ethanol can be build from indigenous yeasts, which are present on every grape. Acetic acid bacteria can then form acetic acid from ethanol. As the micro-organisms on grapes are always present in combination, the management of the crushed grapes will always affect many different factors. Ribéreau-Gayon et al (2006) recommend harvesting the grapes at a temperature below 20°C. Additionally they remark that the harvested grapes must be as intact as possible during the transport. This reduces not only the growth of micro-organisms but also must oxidation and stem maceration.

Must treatment:

When following a reductive way of must treatment, oxidation processes by enzymes should be avoided. Certain enzymes (peroxidase, polyphenol oxidase) are able to transfer oxygen from air to certain wine compounds, resulting in the decrease of the aromatic expression and browning effects in must. For this reason low concentrations of sulphur dioxide and also very low temperatures can inhibit this activity. In general white must is very sensitive to oxidation as the aroma of white must and wine is more fragile than for red mash or wine.

In must clarification, static sedimentation is a common low input treatment. As highly suspended solids in the must are often associated with a negative effect on the wine quality, it is recommended to clarify the must to a low turbidity level of around 200 NTU (Ribéreau-Gayon et al, 2006). Again low temperatures (<20°C) help to facilitate the sedimentation of solids in the must. The elimination of the sediment can also reduce the amount of oxidising enzymes (oxidase activity). The reduction of the oxidase activity can be achieved by taking off the sediment or by inactivation by heat treatment. Heat leads to the denaturation of the enzyme and will also result in a lower need of sulphur dioxide at this point of wine-making (Troost, 1988).

Fermentation temperature:
As the activity of micro organisms always depends on the temperature of the surrounding environment the fermentation activity of the wine yeast *Saccharomyces cerevisiae* is influenced by the temperature of the must. Seen from a metabolic point of view a temperature range from 20-25°C is very favourable for the course of the alcoholic fermentation. But at that temperature one can run risk that the fermentation activity becomes too strong and also some aromatic compounds will be diminished.Thus in general alcoholic fermentations should be performed at a temperature range of 15-18°C in order to reach a complete fermentation without problems. If fermentations are cooled to 10°C or lower specific selected yeast strains should be used which are able to perform the alcoholic fermentation at this temperature. Spontaneous fermentations with indigenous yeasts usually take more time, especially at lower temperatures. Low temperatures inhibit the growth of the indigenous yeasts hence delaying the start of fermentation.

Stabilisation:
Even if the energy consumption is rather high, cold stabilisation is a common way of stabilising wine.There are two main types of precipitation caused by cooling the wine close to freezing point for a restricted period. First there is the precipitation of tartrate crystals. Second there is the precipitation of colloidal substances like unstable colouring matters and proteins. This effective treatment prevents the wine from later precipitation in the bottle assuming that the bottled wine will not be cooled to a lower temperature than that of the treatment. Microbial activity is not eliminated by cold stabilisation. Micro-organisms have to be eliminated by sterile filtration. Further stabilisation is achieved by an adequate dosage of sulphur dioxide before bottling, preventing the wine from aroma loss and colour change during the aging in the bottle. Permanent cool temperatures will slow down the aging process of the wine during storage.

References:
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ACKNOWLEDGEMENT
The authors gratefully acknowledge from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, for the Specific Targeted Research Project “ORWINE” SSPE-CT-2006-022769.