Optimum Usage of Active Dried Wine Yeast

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Follow the directions?
Careful study of the directions on a can or package of yeast will offer the reader much information that is often contradictory; a suggested rate of addition of 5-30 g/hL (more required for white juice and red must—or vice versa); the suggestion to add the yeast directly, or specific directions for rehydration. Some strains that may be assumed to best for primary fermentation of low sugar content musts may be proposed for restarting stuck fermentations... and if the winemaker is really intent on following the directions, they may try the impossible task of 'dissolving' the yeast in ten times its weight of water.

There can be sympathy for the Australian cellar-hand who did as the winemaker said and 'threw' five cans of yeast into the fermenter. He probably read the instructions on the can, became confused, and decided the unopened cans would be just as effective.

What are the correct directions to follow?
- Use 25 g of active dried wine yeast (ADWY) for each hL of juice or must. For most strains, this will provide an inoculation rate of 5 × 10^6 viable cells/mL.
- Rehydrate the yeast in 5 to 10 times its weight of clean water.
- Ensure that the water is 38–41°C at the time of suspension.
- Allow to stand for 15–30 min.
- Acclimatise the suspended yeast to near the temperature of the juice or must to be inoculated.
- Do not inoculate must or juice at a temperature less than 15°C.

Why follow these recommendations?
Inoculation density
As discussed, the addition of 25 g ADWY/hL (with adequate rehydration) will provide an inoculation rate of approximately 5 × 10^6 cells/mL with many, but not all, commercial yeast preparations.

The lag time of any microbial population, in near ideal conditions, is directly related to the inoculum density. Increasing the inoculum density will result in a decreased lag time, up to a density beyond which no further decrease in lag time is noted. A very high cell density the population will not increase as a result of the phenomenon known as the 'crowding effect'.

The critical cell density in grape juice beyond which the lag time does not decrease is determined by many factors. It is the author's experience that the optimum density, above which no decrease in lag time will be observed, is approximately 3 × 10^6 cells/mL—which equates to approximately 15 g ADWY/hL.

There is, however, another important factor to consider: the fact that wine yeast cannot grow indefinitely without access to molecular oxygen. However this is not applicable to winemaking. Fatty acids can be found on grape skins and these can promote yeast growth. Oxygen can be considered a micronutrient under the fermentative conditions found in grape juice. Moderate growth can be maintained by the metabolism of added sterols and fatty acids in the absence of molecular oxygen.

The ability of yeast to divide is impaired when the concentration of sterols and unsaturated fatty acids in the cell membrane falls below a critical level, as important non-replenished membrane compounds are depleted by cell division. These membrane solutes are also implicated in membrane fluidity, which confers cold tolerance and alcohol resistance, and mediate in permease-regulated nutrient accumulation by the cell.

Aerobically grown yeast generally show five cell divisions (i.e. five doublings of the initial population). One important factor in achieving an effective fermentation in grape juice is the presence an adequate cell population when the yeast finish growing, which is normally when 30–50% of the sugar remains to be fermented. This population is believed to be approximately 120–150 × 10^6 cells/mL. This population can be obtained when the inoculum density is approximately 5 × 10^6 cells/mL.

It must be noted that different strains of yeast have different rates of catabolism; i.e. the rate at which they can transport sugar into the cell and break it down to end products. Some strains will require a higher cell density to complete fermentation in a given time than others.

Why then the confusion about what should be on the label? The largest users of ADWY in the world are the Germanic countries and France. They have thousands of small wineries, many which lack refrigeration, so if an 'adequate' amount of yeast is used, the fermenters tend to overheat, which may cause slow or stuck fermentation. The directions are for these rustic operating conditions, and not necessarily for the production of quality wine.

French winemakers should monitor their fermenters and at the time yeast stop growing, add oxygen (as air) to boost activity. This is considered by the author to be a time-demanding activity which can be avoided by the addition of an adequate inoculum. It also has the disadvantage if being inconsistent with...
Trehalose lowers membrane phase transitions in dry yeast cells. Trehalose assist in the maintenance of cell viability during rehydration by preventing phase transition events in the lipid bilayer, thereby protecting the membranes against damage. The effects are mediated by the binding of the hydroxyl groups of the sugar molecule to the polar head groups of phospholipids, in locations otherwise occupied by water molecules.

Trehalose lowers the temperature of the transition in the lipid bilayer from dry gel to liquid crystal from around 60°C to approximately 40°C, thus allowing yeast rehydrated above 40°C to avoid the damaging effects of passing through a phase transition at a physiological temperature. If rehydrated below the phase transition temperature 38–40°C, .Saccharomyces cerevisiae cells leak cytoplasmic contents into the rehydration media, and suffer high mortality rates. The rehydration temperatures in the range 5–50°C. Note that a concentration of trehalose of 150 mg/g dry weight is not unusual in ADWY. Cells harvested in the stationary growth phase with approximately 86 mg trehalose/g dried cells show a substantial increase in survival when rehydrated at 40–45°C. Cells dried from the active growth phase with approximately 7 mg trehalose/g dry weight have a low survival rate at all rehydration temperatures in the range 5–50°C. Note that a concentration of trehalose of 150 mg/g dry weight is not unusual in A DWY.

Inoculate juice and must above 15°C. A complete fermentation of grape juice requires a population near 150 x 10^6 cells/mL (which are in a healthy physiological condition) when the population has finished growing. The remaining sugar will then be metabolized at a rate which is dependent on the temperature and yeast strain. If the temperature is significantly different to the optimum for growth the cell biomass will be reduced. It is therefore recommended that the temperature at inoculation be above 15°C. This will also minimize the lag time, which in turn allows the cell population to increase before the temperature is decreased in order to control the rate of fermentation.

Storage of dried yeast
Yeast stored in its original vacuum packaging below 10°C, but not frozen, maintains adequate viability for up to three years after manufacture for it to be used at the recommended rate of addition.

Conclusion
Despite the use of the correct methodology in the preparation and inoculating of A DWY, fermentation problems may still occur due to the yeast responding to their chemical and physical environment during fermentation.

References