Using Selected Yeast Strains to Reduce Wine Total Acidity

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A balanced wine should be the goal of every winemaker – not only in the wine's chemistry, but in the wine's aroma and flavor. While the latter is often up to interpretation (heavy-handed oak treatment is an example), much is known about how taste components such as acidity, sweetness, and alcohol can work together in harmony or discord on the palate. Cold-hardy wine grapes developed at the University of Minnesota are rarely harvested with a total acidity (TA) under 10 g/L. It is not uncommon to see total acidity at harvest of 15-18 g/L in Frontenac, and even the newest cultivar, Marquette, ranges from 9-13 g/L.

Wine balance. In production of dry wines with high-acid fruit, wine balance can be a trickier dance, as sweetness can help soften acidity. In technical terms, any wine with less than 5 g/L (0.5%) residual sugar when the yeast population dies may be considered dry. The perception of dryness, on the other hand, can vary based on other aspects of the wine, such as dry extract, aroma, and acidity. A wine that is dry and acidic can taste harsh, astringent, and un-balanced to the consumer. This is especially important in dry red wine production, as tannin will accentuate the sensation of dryness on the palate. Winemakers using cold-hardy cultivars to make dry wines must consider ways to manage their acidity.

Microvinification lots, each containing 500 mL of juice, were used to assess the ability of several different yeasts to reduce total acidity. Replications from the Marquette study are shown in the photo.

photo: Katie Cook, University of Minnesota

Lowering acidity. There are three general methods one can use to lower high acidity in dry wine production: physical methods (blending and amelioration), chemical methods (bicarbonates), and biological methods (yeast and bacteria). For the acid levels seen in northern vineyards, the best approach is most likely a combination of all three of these methods. The *Northern Grapes Project* will be exploring these methods individually, so that winemakers can have a host of different tools for reducing acidity in their own wines. Chris Gerling covered chemical deacidification in the August 2013 issue of *Northern Grapes News*, and in this article, I will review the biological deacidification trials we are conducting at the University of Minnesota enology lab.

Biological Deacidification. The most important thing to remember about biological deacidification is that it only affects the malic acid portion of your wine's total acidity, but does not reduce tartaric acid. The most common method of biological deacidification is through malolactic fermentation (MLF). Although not a true fermentation, lactic acid bacteria existing naturally in the environment have the ability to consume the malic acid in grapes and convert it to lactic acid. Nearly all red wines around the world undergo MLF and some white wines also benefit from this practice. Traditionally, red wines are stored in barrels following alcoholic fermentation, where MLF will naturally occur as long as the wines are left unprotected by sulfur dioxide. Wineries choosing to allow "spontaneous" MLF to occur often have to wait months for the malic acid to be consumed. The risks involved with leaving the wine unprotected by sulfur dioxide have pushed many wineries to use a starter culture of lactic acid bacteria, which are now readily available on the market. The University of Minnesota is currently working on projects with MLF in cold-hardy grapes as part of our *Northern Grapes Project* de-acidification trials.

Malic acid and Yeast. Yeast also have the capability to consume malic acid, though they convert it to ethanol through malo-ethanolic deacidification rather than lactic acid. This can cause a slight increase in a wine's alcohol content, though sometimes this is preferred over the aroma and flavor of lactic acid. It has long been known that certain yeasts (*Schizosaccharomyces pombe, Hanseniaspora occidentalis, Issatchenkia orientalis*) are especially efficient at converting malic acid. However, because these yeasts have poor alcohol tolerance, they must always be used in conjunction with *Saccharomyces* yeasts in order to complete fermentation in wine. While *S. pombe* has been available commercially for some time for use in wine production, the development of other non-*Saccharomyces* yeasts for commercial use is a hot topic at the moment. We will likely see more of these yeasts available in an active-dry form to use in sequential yeast inoculations for wine.

Until then, we decided to look at some of the commercially available *Saccharomyces* yeast strains that have a reported ability to reduce malic acid, and trialed them with cold-hardy grape cultivars. After consulting with several enological product suppliers, we came up with a list of several different yeast strains: Exotics (Anchor), and Lalvin C, Lalvin ICV Opale, and Uvaferm VRB (all from Lallemand). We also trialed a non-*Saccharomyces* yeast that Lallemand has made available in an active dry form for sequential inoculations: *Torulaspora delbrueckii* (sold commercially as Level 2TD). Although its malate-consumption hadn't been verified, a technician at Lallemand recommended it because they had observed some softening of the acidity in wines that had been fermented using it.

photo: Anna Katharine Mansfield, Cornell University

White wine yeast trials at the Vinification and Brewing Technology Laboratory at Cornell University. In 2013, the V&B Lab made 73 different wine lots for Northern Grapes Project trials.

Yeast deacidification trial. We conducted a small trial with these yeasts, using frozen juice from 2012. For each MN cultivar, we trialed three different yeast strains, and used a fourth yeast strain that is not reported to reduce malic acid as a control. For white wines, the control yeast was Lalvin DV10, and for red wines we used ICV GRE as a control. For the experiment, we took one lot of juice, and divided it into 20 micro-vinification lots of 500 mL each; thus each yeast/juice combination was replicated in five fermentation lots. For this initial trial, we were mainly concerned with monitoring the chemistry change using each yeast. The unusually hot weather in 2012 caused initial brix levels to be extremely elevated, so initial malate numbers reflect juice that had been diluted to bring the sugar concentration down to 25° Brix.

Results: The Big Picture. All of the micro-vinification lots saw some decrease in malic acid – even those lots fermented with DV10 and ICV GRE, which have no reported ability to consume malate. However, while the control yeast did consume some malate, the quantity it consumed was probably not enough to make a significant impact in the overall perception of a wine's acidity. By far, the best-performing yeast was Lalvin C. It was able to consume up to 35% of the initial malic acid from the juice, with an actual reduction of up to 1.6 g/L. This may have huge implications for wines that intend to undergo MLF, as it will reduce the final lactic acid concentration of the wine. Another yeast that performed well was the Anchor 'Exotics' strain, which removed 30% of the malate from our Frontenac juice over the course of fermentation. ICV Opale, and the non-*Saccharomyces* yeast (Level 2TD), didn't out-perform the controls. When used in combination with any of the *Saccharomyces* yeasts, the Level 2TD didn't provide any additional deacidification.

Results: The Nitty Gritty.

Frontenac Gris. We started with a juice that had a total acidity of 9.92 g/L, pH of 3.00, and 5.1 g/L of malic acid (Table 1). All three of the yeast trials showed a significant decrease in malate from the juice. The malate reduction was significantly greater than the reduction seen in the control ($p<0.05$), though there is no statistical difference among the malate-reducing strains used. Thus, any one of these three yeasts, or combination of yeasts, should perform roughly the same in regards to their malic acid reduction. It is worth noting that we did see some stuck fermentations in all five of the micro-vinification lots using the 'Exotics' strain, so extra precaution may be needed with low pH juices.

Frontenac gris	Avg. malate concentration in wine (g/L)	Avg. malate reduction from juice (g/L)	% Malate reduction from juice	Statistical significance
DV10 (control)	4.28 ±0.002	0.8	16%	a
Lalvin C	3.48 ±0.002	1.6	31%	b
Exotics	3.74 ±0.003	1.4	26%	b
TD + Exotics	3.56 ±0.003	1.5	30%	b

**Treatments with the same letter are not significantly different at the α=0.05 level.*

La Crescent. The La Crescent juice had 5.3 g/L of malic acid at the beginning of fermentation (Table 2). With the yeast strains chosen for the La Crescent fermentations, the decrease in malic acid was less pronounced than what we saw with the Frontenac Gris. In fact, only the micro-vinification lot in which Exotics was used showed a statistically significant drop in malic acid ($p< 0.05$) over the control. ICV Opale is advertised to lower malate levels by 0.1 to 0.4 g/L. Our trials show that it exceeded this level of acid reduction in high malate juice; however, this decrease was not significantly lower than our control yeast which has no reported malate reducing properties.

La Crescent	Avg. malate concentration in wine (g/L)	Avg. malate reduction from juice (g/L)	% Malate reduction from juice	Statistical significance
DV10 (control)	4.78 ±0.047	0.52	9%	a
Opale	4.74 ±0.023	0.56	11%	a
Exotics	4.26 ±0.028	1.04	19%	b
TD + Opale	4.70 ±0.015	0.60	11%	a

**Treatments with the same letter are not significantly different at the α=0.05 level.*

Frontenac. Our Frontenac was pressed and fermented as a rosé. Initial malate concentration in our Frontenac juice was a relatively high 4.6 g/L after ameliorating to 25 brix (Table 3). All yeast used for this trial caused a decrease in the final malic acid concentration of the wine. Again, the Lalvin C outperformed the Exotics, as well as the control (ICV GRE). There is no statistical difference between the observed malate reduction when using Lalvin C with or without T. delbrueckii yeast. This (along with the other results seen when using T. delbrueckii) suggests that any impact on the perception of acidity due to this yeast is likely not related to malate degradation. All the Frontenac fermentations finished dry with no stuck or sluggish character

Frontenac	Avg. malate concentration in wine (g/L)	Avg. malate reduction from juice (g/L)	% Malate reduction from juice	Statistical significance
ICV GRE (control)	3.40 ±0.05	1.2	26%	a
Exotics	3.18 ±0.02	1.42	30%	b
Lalvin C	3.02 ±0.02	1.58	34%	c
TD + Lalvin C	2.98 ±0.07	1.62	35%	c

**Treatments with the same letter are not significantly different at the α=0.05 level.*

Marquette. Marquette was also pressed immediately and fermented as a rosé. The ameliorated juice had an initial malic acid concentration of 4.1 g/L (Table 4). Exotics and VRB showed identical malate reduction capabilities, and even though the difference between these two yeasts and the control (ICV GRE) was only slight, the difference is statistically significant (p=0.046). Once again, Lalvin C proved to have the greatest potential for malate reduction, with a 1.10 g/L decrease in malic acid concentration from the juice. Nonetheless, the differences seen in acid reduction in Marquette with the various yeast strains probably aren't going to have a great impact on the final difference in acid perception of the wine.

Marquette	Avg. malate concentration in wine (g/L)	Avg. malate reduction from juice (g/L)	% Malate reduction from juice	Statistical significance
ICV GRE (control)	3.38 ±0.002	0.72	18%	a
Exotics	3.28 ±0.007	0.82	20%	b
VRB	3.28 ±0.017	0.82	20%	b
TD + Lalvin C	3.00 ±0.00	1.10	27%	c

**Treatments with the same letter are not significantly different at the α=0.05 level.*

It is important to keep in mind that there are many different tools available to a winemaker to manage high acidity in their wines. The selection of yeasts that we looked at here is only a small example of what is available on the market. It is important to talk with technicians who supply your winery in order to get a better idea of what products might help with managing your acidity