UC Davis Research Leads to Specialty Yeast-producing Company

Research identifies yeast strain that metabolizes sulfur efficiently and with little or no leakage of hydrogen sulfide

Eric Stern

Winemaker emeritus **Eric Stern** of Landmark Vineyards retired in 2010 after 22 vintages with the Kenwood, California producer.

THE IDENTIFICATION, ISOLATION AND selective breeding of specialized yeast is a relatively new industry, considering that winemaking is thousands of years old. **Louis Pasteur**, working in 1862 to elucidate problems in wine spoilage, can be credited with being the first scientist to observe and study the role of yeast in fermentation. In 1876 Pasteur published *Studies on Fermentation* and stated in his preface, "Time is the best appraiser of scientific work, and I am not unaware that an industrial discovery rarely produces all its fruits in the hands of its first inventor."

Commercialization of Pasteur's discovery took until the beginning of the 20th century to reach fruition. A 2010 report, authored by Dr. **Ulrich März** for **BCC Research** of Wellesley, Massachussetts, stated that the global market for yeast, yeast extracts and autolysates and related products will have a market value of $5 billion by 2015, an increase from $3 billion in 2009. This represents an annual compounded growth rate of nearly 8 percent, "rare for the food and chemical ingredients and intermediates industry," according to März.

More than 600 yeast factories are currently in operation worldwide, and "the probability of new construction is high in an industry in which a few international companies dominate new investments," according to the report, which runs to 130 pages and costs $5,653.

The wine industry accounts for a very small percentage of this industry, (about 1 percent), which is dominated by the baking industry, but is following the trend of growth. One new investment has been **Renaissance Yeast**, based in Vancouver, British Columbia. Renaissance was begun in July of 2013 with the goal of serving the wine industry's need for non-H_2S producing yeast.

Research by professor **Linda Bisson** at the **University of California, Davis** helped lead to a licensing agreement with Renaissance Yeast to cross-breed a particular yeast, known as UCD 932. Her work, assisted by her Ph.D. students, identified a specific variation or mutation on a specific gene, known as MET-10, that enables this yeast to metabolize sulfur efficiently and with little or no leakage of hydrogen sulfide (H_2S), a compound that smells like rotten eggs.

John Husnik, Renaissance Yeast CEO, has played a role in the commercialization of Bisson's discovery, which he characterized as "elegant." Husnik, a Ph.D. microbiologist specializing in the genetics of *Saccharomyces cerevisiae*, the principal yeast in beer and wine fermentation, oversees the breeding of non-H_2S yeast for Renaissance Yeast.

The commercial process requires laboratory validation at each cross-breeding step through at least six generations of sporulation or sexual crossing of the yeast with "workhorse" strains to ensure that the desired non-H_2S production is retained. The work entails screening each generation and submitting it to challenges, such as an ability to ferment with low nitrogen and high SO_2. This helps ensure that winemakers will be satisfied with the yeast and not have H_2S problems in their wines. After successful validation by Renaissance, the new cross-breed strain was ready for industrial-scale production in batches of a ton or more.

According to Husnik, Renaissance is currently using two manufacturers. One factory is certified organic and is in Germany. It uses only certified organic nutrients, molasses and sugar, and no chemical emulsifiers for its production. The other supplier is in China and produces a conventional version of the yeasts, without needing to use organic ingredients to feed them. He said that both facilities maintain the same high standards of purity and guarantee very high rates of yeast viability, $1x10^8$/gram, and extremely low levels of lactobacillus contamination, less than 10 CFM/gram. The organic product has a two-year shelf life while the conventional ADY (active dry yeast) has a three-year shelf life, attributed to the use of emulsifiers that aid in the drying and preserving process, he added.

The reported thresholds for detection of H_2S in wine "vary depending on the type of wine and interactions with other wine aromas," according to **ETS**, a wine laboratory located in St. Helena, California. Their website lists a range of from 0.9 to 1.5 micrograms per liter. At higher levels H_2S is considered to have a negative effect on the aromatic and fruit quality of a wine, particularly in sparkling, white and Rosé wines. Husnik stated that even at low levels, H_2S-free wines are superior or more appealing than wines containing H_2S. Subjective wine evaluations are interesting and reveal cultural or geographical bias as much as anything else. Some tasters undoubtedly will prefer "clean" wines to slightly H_2S-tainted wines, whereas others may choose the "greater complexity" of the H_2S influenced wine.

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Best Practices for Reducing H_2S Development

Levels of H_2S where the rotten egg smell is pronounced may render a wine unsuitable for commercial use. Remedial actions, such as aeration to blow off this volatile compound and fining with copper, where the sulfide binds with the reactive copper to form insoluble copper sulfide, nearly always, when successful, result in somewhat diminished wine quality. The potential for the H_2S to re-form at some future time, particularly under reduced conditions, e.g., in the bottle, is also a troubling scenario for winemakers. With the popularity of the ever more ubiquitous screw cap, the problem of reductive H_2S formation in the bottle has become more prevalent.

Avoidance of H_2S is always desirable. Vineyard and cellar practices to minimize H_2S production include judicious and conservative use of elemental sulfur or sulfur-containing sprays as a mildewcide in the vineyard, particularly five to eight weeks prior to harvest, and measurement of the nutritional status of musts and juices prior to fermentation. Winemakers need to closely monitor fermentations to ensure healthy and complete fermentation. Elemental sulfur from vineyards can produce H_2S regardless of the strain of yeast used to ferment or fermentation kinetics. It is a chemical process. Low nutrient levels can cause stress for yeast that results in H_2S production.

If white grapes arrive with excessive vineyard sulfur, careful settling and racking may be the best recourse to try and eliminate some of the sulfur, but for red grapes that contain excess sulfur from sprays, the winemaker has fewer options to eliminate the potential for stinky H_2S formation during fermentation.

Control of vineyard sprays and applications should be routine, but weak soils, vineyard age, vine decline or disease, as well as high sugar grapes and late season harvesting, can contribute to low nutritional status and higher alcohol, which can stress yeast and result in H_2S formation.

Higher solids in white juice and poor temperature control in the cellar may also contribute to higher H_2S. Reductive winemaking practices, such as high ratio tank height to width in red wine fermentation and inadequate aeration and cap management, can also result in elevated levels of H_2S production.

Wines Made with Renaissance Yeasts

Linda Trotta, winemaker at **Swiftwater Cellars** in Cle Elum, Washington (annual production 4,500 cases), has been using Renaissance yeasts for four vintages. Her usage has been vintage-dependent. In cooler, wet years, like 2010 and 2011, she used these yeasts for about 25 percent of her wines and only in about 5 percent of them in 2012 and 2013, which were drier and warmer vintages. The extremely low nutritional status of her grapes from vineyards with sandy and volcanic soils dictated her preference for Renaissance yeasts. Usually, YAN (yeast assimable nitrogen) numbers should be between 200 and 300 ppm—some of her grapes were 50 ppm, a struggle for any yeast. While Trotta produces mostly red wines, she found that the Renaissance yeasts are particularly suited to her limited white wine production where delicate aromatics could be overpowered by H_2S and the subsequent need to use larger quantities of copper to fine away the sulfides.

She has conducted experiments, comparing the Renaissance yeast strains with other commercial strains not selected for reduced H_2S production; and while she finds the Renaissance yeasts produced wines that were "magical" in the elimination of H_2S, she also commented that they "lacked complexity" and were "completely clean, straightforward." She was willing to sacrifice some of the complexity, though, for the cleanliness while retaining the ability to blend the two lots to achieve a more interesting final wine—a wine uncompromised by H_2S.

David Noyes at **Wellington Vineyards** (annual production of 9,000 cases) in Sonoma Valley has also been an advocate of Renaissance yeasts. In one case, a particular late-season Cabernet Sauvignon vineyard in a cool coastal site had always produced a wine with H_2S problems. Since the winery doesn't measure YAN, the actual cause of excessive H_2S in this wine cannot be attributed to low nitrogen. But the higher Brix and the lateness of the vineyard to ripen undoubtedly contributed to stressed fermentation conditions and higher H_2S production. With the Renaissance yeast the stinky "hair salon" aromatic quality of this vineyard has been eliminated, he said.

Noyes also found that the winery's white wines benefited from the use of Renaissance's "Allegro" yeast. An issue in their white wine production is good settling and separation of solids prior to fermentation. With a tendency toward higher solids fermentations, H_2S in their white wines has been a problem. The virtual elimination of H_2S, despite higher levels of solids, has been a welcome benefit with these yeasts.

Jason Burrus of **Chrysalis Vineyards** in Middleburg, Virginia has been familiar with these non-H_2S producing yeasts since his graduate student years at UC Davis. His winemaking career began in California's Central Valley, but he has worked in Virginia since 2006. Chrysalis produces about 10,000 cases per year and is one of the country's largest growers of Norton, a *Vitus aestivalis* and *vinifera* cross that is notable for being one of North America's least-known but worthy red grapes. According to writer **Paul Lukacs**, in his

The Great Wines of America published in 2005, Norton was considered on a par with Europe's Bordeaux and Burgundy wines in the 19th century. Burrus characterizes Norton as being "intensely aromatic" and "extremely dark in color" but notes that it lacks tannin and is therefore oftentimes blended with *vinifera* grapes, such as Tannat or Nebiollo.

Burrus' approach to winemaking at Chrysalis is to make the wines as clean as he can, and in this regard the Renaissance yeasts with their lack of H_2S production are a key component of his style. He said that yeasts don't have as big an effect on flavor as other practices in the vineyards and cellar. He chooses to eliminate H_2S through these selected yeasts, admitting that he is particularly sensitive to the negative effect of H_2S in wine but especially in aromatic white wines and rosés bottled before the end of the harvest year.

As for reds that spend significant time aging in barrel, he said that these show even less of an effect from yeast selection than most other wines. He suggested that winemakers tend to be more attuned to yeast differences because of their periodic tasting of their young wines from tank and barrel following fermentation. Because "consumers only get to taste the wine from the bottle a year or longer after it has completed its fermentation, the impact of the particular yeast strain used to make the wine is of little significance. Far more important to a wine's flavor profile are those things attributed to terroir, vineyard management and cellar practices," he said.

Conclusion

Compromised grapes from highly stressed vines and vineyards that are nutritionally weak or that may contain excessive amounts of sulfur sprays and dust can lead to wines that contain high amounts of H_2S. Recent identification and subsequent breeding of commercial yeasts that minimize H_2S production are a viable alternative to having to deal with H_2S through aeration, copper fining or blending with cleaner wines. Such yeast may not suit every winemaker's style, but the trade-off is eliminating the need for heroic efforts to try to remove H_2S in the finished wine. Sometimes these sulfides can return after bottling, particularly under screw cap.

The market for commercial yeast strains is growing; and while the wine industry remains small in relation to the global market for yeast and related products, Renaissance has, with non-H_2S producing yeast, addressed a serious problem in the industry. Future generations of winemakers will undoubtedly have more options in their selection of yeast strains to aid in the production of wine. Pasteur was indeed prescient in predicting that future scientists would carry on and improve upon the "first inventor." **WBM**