Monitoring Nitrogen Levels in Wine

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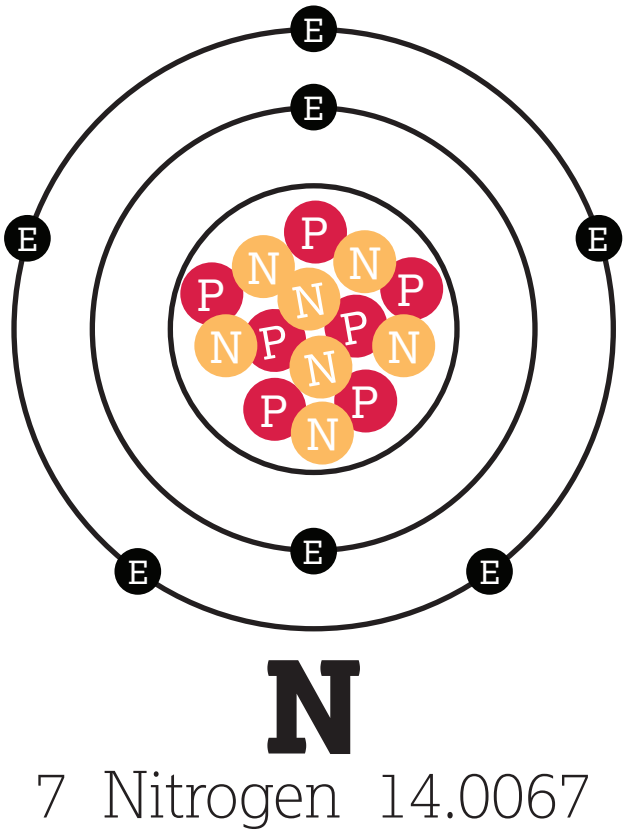

NITROGEN IS A KEY nutrient that yeast requires during the fermentation process, and controlling its levels is essential since it can influence the flavor, aroma and quality of the resulting wine. In order for wine to present a consistent profile from different batches of grapes, it is essential to ensure the correct levels of nitrogen are available at the appropriate times during the fermentation process.

There are several different methods winemakers can use to test for nitrogen, depending on the size and capacity of the winery's operations. Some methods can be carried out in almost any facility size while others require advanced equipment that is only suited to large-scale operations. In this review, we will outline the different types of nitrogen present in the grape and examine the techniques used by winemakers to measure nitrogen levels and subsequently optimize fermentation.

How Much Nitrogen is Needed?

Other than glucose and fructose, nitrogen is the most important nutrient for a successful fermentation. Nitrogen is contained in the grape, and its total content can vary widely between varietals and vineyards, typically ranging from less than 50 mg per liter to more than 1,000 mg per liter. Nitrogen is, however, found in many different forms—each with slightly different chemical composition—and not all forms are metabolized by yeast during fermentation. Yeast Assimilable Nitrogen (YAN) is the form required for fermentation, and it is present as ammonium salts and Free Alpha-amino Nitrogen (FAN).

Ammonia is the simplest form of nitrogen found in the grape and is formed by cellular breakdown reactions, whereas FAN is a more complex form of nitrogen and is found in the amino acids of the grape cells. Both of these nitrogen forms are important for effective fermentation, but their levels are independent of each other since they result from different cellular processes.

During fermentation, both forms of nitrogen are used by yeast, with ammonia utilized first followed by FAN later in the fermentation. It is important that the right amount of nitrogen is available to yeast during the entire fermentation process. Too little nitrogen can result in a slow, stuck or "stinky" fermentation, as lack of nitrogen leads yeast to break down sulfur-containing amino acids, resulting in the production of sulfur dioxide. To ensure an adequate nitrogen supply, winemakers often add ammonia as Diammonium Phosphate (DAP), as well as FAN in the form of complex amino acids found in yeast extract, prior to and during fermentation. At the other end of the spectrum, high volumes of nitrogen (exceeding 450 to 500 mg per liter)[1] can lead to excessive fermentation and the production of undesirable compounds that result in wine spoilage. It is, therefore, extremely important that optimal levels are maintained throughout the process.

Recommending an optimum nitrogen dosing level is difficult since the required amount and dose timing depend on a number of factors, such as the yeast strain, fermentation progress and the original nitrogen and sugar concentration in the grape. According to a study by the **UC Davis** Department of Viticulture and Enology, optimal YAN content for fermentation correlates to the amount of sugar present in the grape as determined by specific gravity measurement (°Brix).

- 200 mg N/L for 21° Brix
- 250 mg N/L for 23° Brix
- 300 mg N/L for 25° Brix
- 350 mg N/L for 27° Brix

Testing for Nitrogen

Since the level of nitrogen can greatly influence the quality of the resulting wine, it is important to monitor levels throughout the fermentation process and adjust them as required. Winemakers can measure YAN or measure ammonia and FAN individually, depending on the depth of analysis required and available equipment budget. The aim of nitrogen analysis is to provide data that the winemaker can use to control fermentation and ensure consistency in each batch.

The simplest way of measuring YAN involves a formol titration. This titration can be performed using a pH meter. Measuring YAN this way throughout the fermentation process often provides enough information for the winemaker to make critical dosing decisions. As a simple and economical choice, formol titration offers the additional benefit of enabling the winemaker to measure titratable acidity at the same time, with a slight modification to

the procedure. Separate ammonia analyses can be performed by adding an ammonia ion selective electrode. By changing the electrode, the winemaker can also use the pH/ISE meter to perform a number of other critical tests, such as pH, potassium, and titratable acidity, or a titration to determine sulfur dioxide content.

If the wine producer would like to analyze other forms of nitrogen, such as FAN, and test for other compounds, the use of a spectrophotometer may be required. Using a spectrophotometer, a winemaker can measure ammonia and amino nitrogen levels using enzymatic methods (for ammonia or amino nitrogen) or a dye binding test, such as NOPA (amino nitrogen by o-phthaldialdehyde assay). While a spectrophotometer represents a large initial investment and has higher operating costs due to the continual investment required in replacing reagents, it is more versatile as it can be used to test other parameters that might be of interest. Parameters that can be measured with a spectrophotometer (with the correct reagent) include glycerol, sulfur dioxide, sugars, acids, color and phenols. Depending on the winery's production facilities, the ability to analyze some of these parameters could help the winemaker find ways to improve wine quality.

Adjusting Nitrogen Levels

Many winemakers add a standard amount (around 100 to 300 mg per liter) of DAP to juice or must to increase the rate of fermentation before actually measuring nitrogen levels[2]. As discussed above, it is very important to adjust nitrogen based on the required flavor profile, as too much DAP can cause the wine to become overly acidic. This is due to the presence of phosphoric acids that are formed as by-products when yeast consumes nitrogen. To ensure that fermentation doesn't become too rapid, nitrogen levels should be measured from the offset and DAP added in small quantities determined by this measurement.

Another method of increasing nitrogen levels is through the addition of complex amino acids in the form of yeast extract prior to fermentation. Yeast extract is primarily comprised of the more complex forms of nitrogen, such as FAN, and also contains other vitamins and micronutrients that could improve wine quality.

Perfecting the Art of Winemaking

Nitrogen is a very important nutrient in fermentation, and it can heavily influence the aroma, taste and character of the end product. Measurement of nitrogen levels before and throughout the fermentation process gives winemakers the opportunity to adjust the amount to achieve the desired quality of wine. Obtaining control over nitrogen levels can help to ensure consistency across production lots, something that is very important in a commercial setting.

Winemaking involves artistry, and its subjective nature makes it very difficult to provide stringent guidelines for the amount of nitrogen and other nutrients required to produce certain wine profiles. Ultimately, every winemaker has their own formula for creating what they consider the "perfect" wine. **WBM**

References

1. Leonardelli. M, "Why, When, and How to Measure YAN," Enology News and Notes, Fall/Winter 2013-2014.
2. *www.wineserver.ucdavis.edu/industry/enology/fermentation_management/wine/practices.html*