Oregon Wine Advisory Board
Research Progress Report

1996 - 1997

Nitrogen Compounds in Oregon Musts and Wines

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Introduction

Over the last several years many Oregon winemakers have expressed concerns over the frequency of 'stuck' and sluggish yeast fermentations. These problems are probably due to low nitrogen status of musts at harvest. Malolactic fermentations may also be affected by low levels of fermentable nitrogen in juice and wine. Low levels of assimilable nitrogen can cause nutritional stress in yeast and the production of hydrogen sulfide by degradation of grape juice proteins containing the sulfur amino acids cysteine and methionine. Nitrogen compounds (N) are used by yeast for the production of cell biomass, proteins, and enzymes necessary for the biochemical processes of fermentation. Grape juice nitrogen status can vary greatly depending on variety, soils, vineyard site, water stress, and climate (vintage). Other factors that may affect nitrogen status include grape maturity, effects ofjuice clarification prior to fermentation, fermentation practices, and differential utilization by different yeast strains. Although 400 to 500 mg of assimilable N per liter ofjuice are required for maximum yeast biomass production, about 150 mg/L is generally required to complete fermentation ofjuice to dryness. This assumes a large initial inoculum size of about 106 cellshnl or more and a typical 10-20 fold increase in yeast biomass during the course of fermentation.

Nitrogen supplementation by the addition of diammonium phosphate and yeast extract preparations can help to balance nutritional deficiencies in juice. Excessive additions, however, may be detrimental to wine quality and stability. For example, elevated levels of some amino acids may lead to 'off flavors due to the production of undesirable levels of fusel alcohols. Post fermentation microbial stability may also be affected. Increasing the amino acid content ofjuice by adding N-based supplements may also increase the risk of formation of ethyl carbamate, a known mild carcinogen found in fermented foods.

Currently there is little data on the nitrogen content of Oregon musts and wines. It is important to begin to develop a data base on the nitrogen content of musts at harvest and of wines during fermentation in order to develop guidelines to assist winemakers on what types and levels of nitrogen supplements to use in order ensure healthy fermentations.

Current Progress and Discussion

From the 1996 vintage we are monitoring the nitrogen content of commercial musts and fermenting wines from 10 cooperating commercial wineries. Analysis includes total nitrogen (total Kjeldahl digestion), ammonia, and alpha-amino acid content. Selected samples will also be analyzed for complete amino acid profiles. The alpha-arnino acid content is being analyzed using a new spectrophotometric

analysis method recently reported by Dukes and Butzke (University of California-Davis). An approximation of the total yeast assimilable N of a juice can be obtained by adding the mg/L of N from the alpha-amino acid analysis and the mg/L of N from the ammonia analysis. Total nitrogen content by itself has been shown to correlate poorly with the incidence of problem fermentations. Ammonia analysis done previously (80 juice samples from 1992-1995) showed levels as low as 11 to as high as 98 mg/L in Oregon musts and juices prior to fermentation. The range of total N observed was as low as 61 to as high as 526 mg/L (Figure 1). During the 1996 vintage, juice samples were taken prior to fermentation, prior to nutrient addition, midway through fermentation, and from new wines at dryness. A total of 194 samples are currently being analyzed.

Alpha-amino acid content in 1996 juice and must samples prior to fermentation (and nutrient addition) ranged from about 43 to 378 mg (N)AL with an average of about 137 mg/L. Many samples were significantly lower than 100 mg/L. Pinot gris juice samples ranged from 63 to 378 mg (N)AL, Chardonnay from 43 to 276 mg (N)AL, and Pinot noir from 75 to 286 mg (N)AL. On the average, Pinot noir must samples had higher alpha-amino acid content than Pinot gris or Chardonnay juice samples. The alpha-amino acid content appears to be rapidly utilized by yeast early during fermentation. Samples analyzed at mid fermentation contained an average of only about 33 mg (N)/L. Levels in new wines at dryness were slightly higher averaging 59 mg (N)/L, possibly due to excretion by yeast or to yeast autolysis at the end of fermentation (Figures 2, 3, and 4). The ammonia analysis of the 1996 juice and must samples is still in progress, but based upon analysis of ammonia levels in juice from previous years it is likely that a number of'juice samples from the 1996 vintage will have a sum of yeast assimilable N (alpha-amino acids + ammonia) less than the approximate 150 mg (N)IL generally assumed necessary for healthy fermentations.

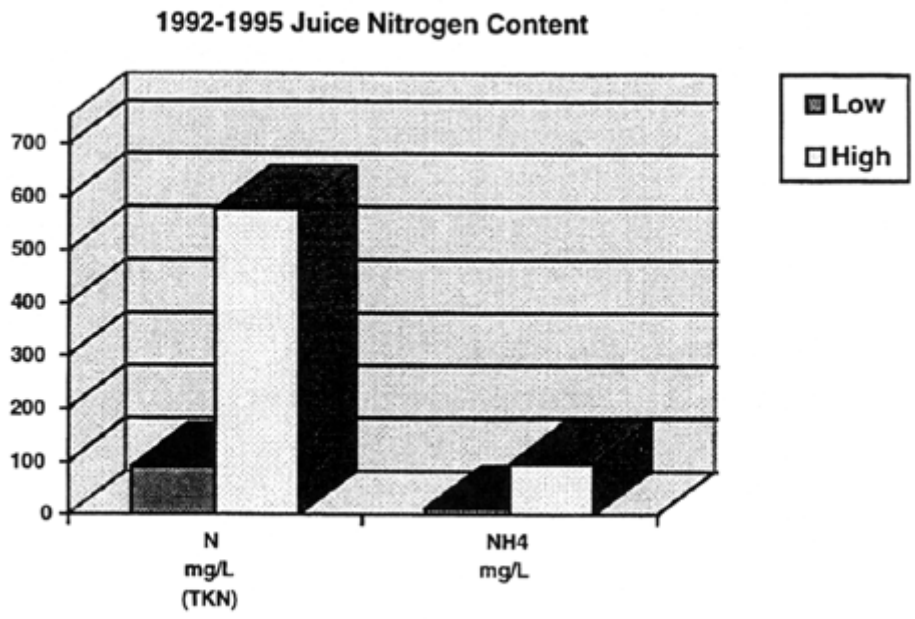

Figure 1

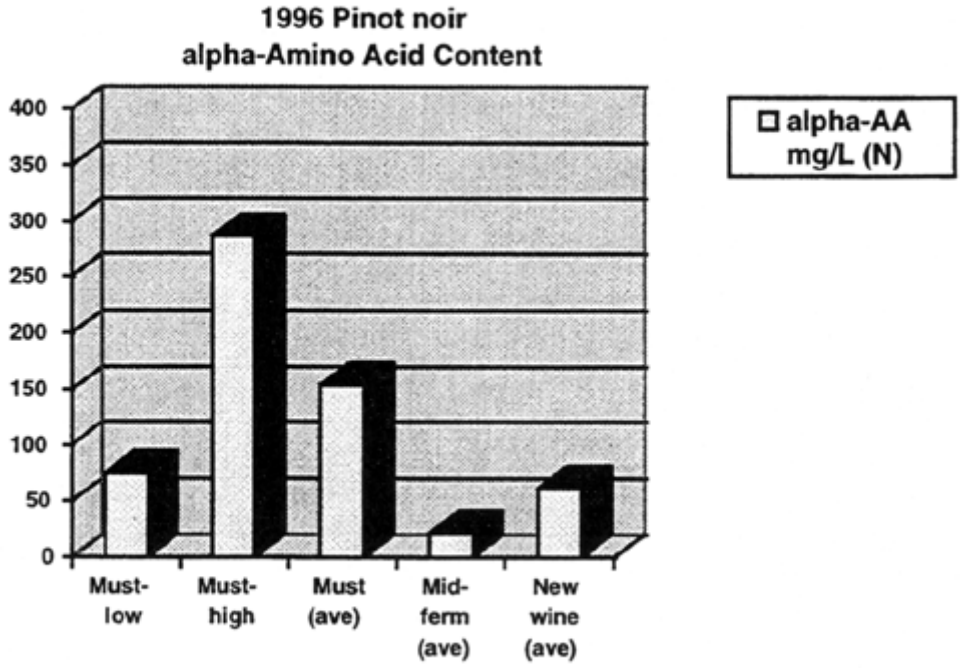

Figure 2

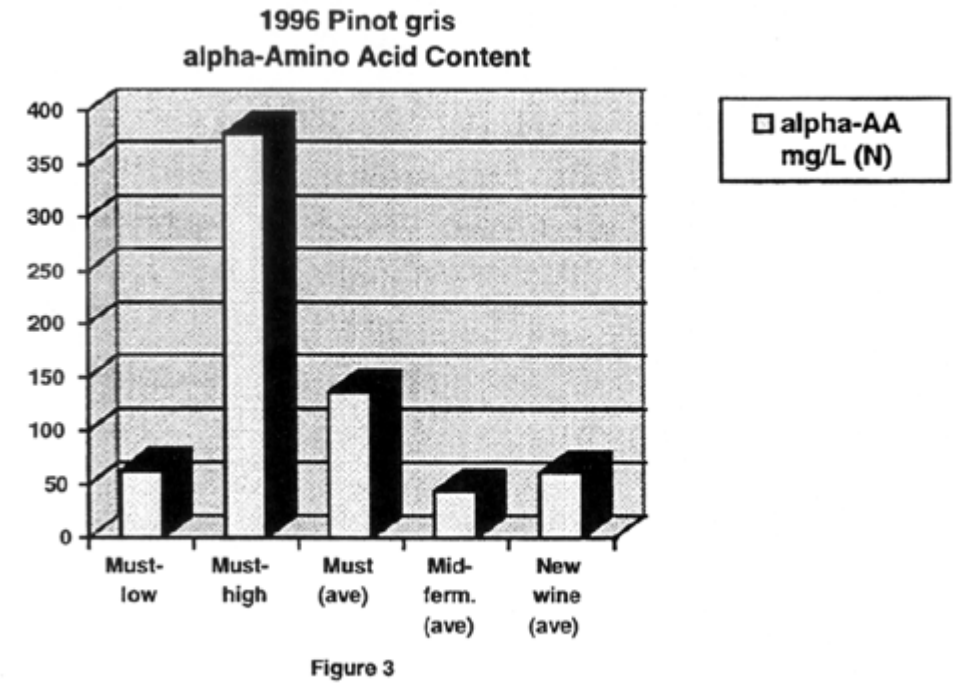

Figure 3

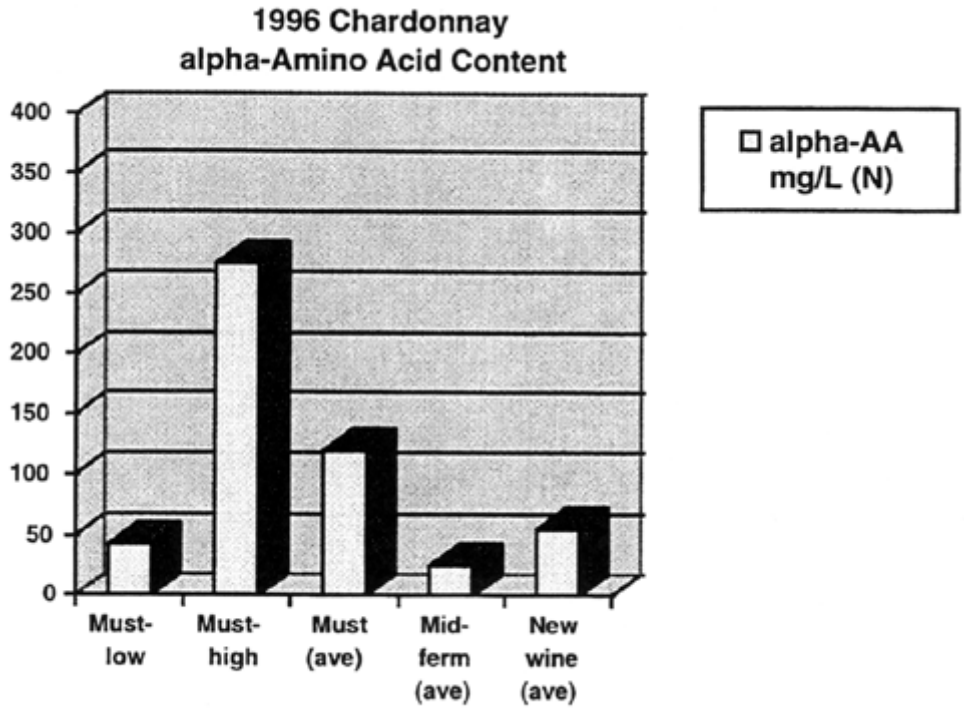

Figure 4

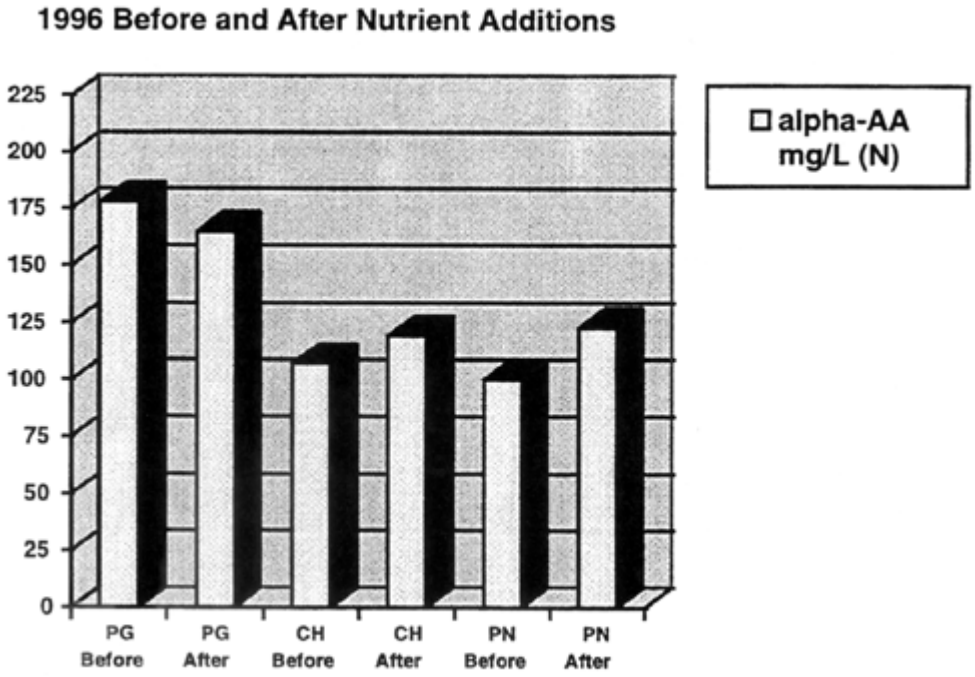

Figure 5

A number of commercial juice samples were analyzed before and after yeast nutrient additions. The effect of the addition of yeast nutrients on the alpha-amino acid content ofjuice prior to fermentation varied considerably. In many case, yeast nutrient addition had no effect on the alphaamino acid content of the juice or must. On the average, the alpha-amino acid content increased moderately after nutrient addition to Chardonnay juice (8 samples) and Pinot noir (3 samples) but not to Pinot gris juice (6

samples) (Figure 5). Additions ranged from 2 to 5 lbs of yeast nutrient per 1000 gallons. Solubilization of the nutrient preparations may be an issue. The highest average increase was observed in Pinot noir where the fermentation temperatures would have been significantly higher. The actual N content of the commercial nutrient preparations may also vary considerably.

The nitrogen composition of the juice and fermenting wines will be compared with the rate of fermentation and the number of days to dryness. This will help us to begin to develop guidelines for assessing nitrogen status and proper nutrient additions for healthy fermentations in Oregon wines. During 1997 we propose to identify specific vineyard blocks of fruit that we can monitor during the growing season as well as during fermentation for nitrogen status and fermentation behavior. Petiole nitrogen analysis at bloom, for example, may correlatewith nitrogen content of fruit at harvest and allow an early prediction of the nitrogen status at harvest.