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High Alcohol Fermentation of Grape Juice Concentrate VI-98

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Abstract *Grape juice concentrate is used by many small countries that cannot grow grapes as a source for a wine industry. Concentrate can be fermented to normal and high alcohol content under special conditions. Wines made from concentrate may need nitrogen and nutrient supplementation to prevent a stuck or sluggish fermentation. Objectives of this study include examining an Evapor® thin film concentrating unit to concentrate juice for wine production, determining Free Amino Nitrogen content of juice and reconstituted juice, and fermenting juice made from concentrate using the Evapor® system to produce a wine and a high alcohol product. Concentrates made with Evapor® system were provided by Canandaigua Wine Company and yeast and yeast nutrients were provided by Lallemand Company. Juice was fermented at 35 ^{o}Brix with the yeast strain L2226 to produce a high alcohol product. Fermaid and diammonium phosphate were added at 2 g/L or 0 g/L, and wine was placed in an orbital shaker to ferment. Results show that fermentation of the 35° Brix juice was successful after 35 days to produce high alcohol products with alcohol contents ranging from 13.9 to 16.7%. The Evapor® concentrating unit produces a high quality juice that can easily be fermented to produce a wine or a high alcohol product. This method produces a consistent alcohol concentration of a port-like product that can be made naturally.*

Introduction Concentration of grape juice has become a significant part of the grape processing industry. Grape concentrate provides many advantages to the processor by lowering shipping and storage costs. The aim in concentrating grape juice is to produce a stable, easily handled and stored form of the juice that reconstitutes quickly to a high quality product resembling the original juice as closely as possible (Van Arsdel et al. 1973).

Evaporators

Evapor® System. The Evapor® system utilized in this project was a centrifugal, thin-film evaporator. It was originally developed by Dipl.-Ing. Vaclav Feres in West Germany. This is a new type of evaporator that uses centrifugal force to create a uniformly thin product film that flows over the heat-transfer surface. Liquid film produced on the rotor by centrifugal force is 0.1 mm thick. No laminar flow nor localized overheating of the process liquid occurs. This results in rapid product treatment and an extremely short residence time of approximately one second at an evaporation temperature of only 48.8°C. Foaming is eliminated because of centrifugal force to liquid film on moving heat transfer surface. Evapor is easy to monitor while operating and easy to inspect, clean, and sterilize after use.

High alcohol production

Fermentation problems associated with grape juice concentrate. Stuck fermentations can be linked to sugar concentration, pH, total nitrogen, inadequate yeast growth, and cell biomass yield, which are all critical for optimal fermentation activity. Sugar, assimilable nitrogen and vitamins are of great importance to winemakers. Fermentation activity is reduced in musts of high sugar concentrations. A deficiency of assimilable nitrogen in must has been linked to poor yeast growth, stuck fermentations and production of hydrogen sulfide. Pre-fermentation processing of musts may lower the concentration of essential yeast nutrients, thereby increasing the possibility of a sluggish or stuck fermentation and reduced yeast growth (Eglinton and Henschke 1993). In brewing, stuck and sluggish batch fermentations in very high gravity worts seemed to be caused by insufficient levels of yeast nutrients and the effect of these nutrients on tolerance of the culture to ethanol (Ingledew and Kunkee 1985). Many high gravity worts are known to be nitrogen deficient. Nitrogen content is one of the limiting factors of yeast growth and sugar attenuation. Addition of assimilable nitrogen can increase fermentation rate and can reduce time required for fermentation completion (Bely et al. 1990). It is generally accepted that 150 mg/L of free amino nitrogen (FAN) is required in a wort for a normal fermentation. Enologists have demonstrated that large amounts (over 500 mg/L) of assimilable nitrogen when present with oxygen (and/or substitutes), resulted in very rapid batch fermentations of musts and worts of very high initial sugar concentrations (Ingledew et al. 1986).

Wine microbiology. Yeast growth can be inhibited by high concentrations of sugar and the accumulation of ethanol in the cell (Ribereau-Gayon 1985). It is now known that by altering the nutritional conditions, it is possible to increase ethanol yield as well as the. survival of yeast at high concentrations of ethanol (Thomas and Ingledew 1990).

Each must possesses, from its extraction, a particular fermentability. Fermentability of juices made from concentrate are affected by the concentrating unit. Many units strip juice of essential vitamins and nutrients that yeast need in order to produce a successful fermentation. This deficiency must be determined prior to fermentation to supplement juice with nutrients to obtain a successful fermentation (Ribereau-Gayon 1985).

Use of yeast nutrients in fermentations. Insufficient levels of yeast nutrients have been considered to lead to a reduced yeast tolerance of ethanol, and of these nutrients, assimilable nitrogen levels can be critical. Additives of assimilable nitrogen have been shown to increase sugar usage and ethanol formation (Allen and Auld 1988).

Yeast hulls, or yeast ghosts, have been reported to enhance fermentation rates and prevent stuck or sluggish fermentations. These act as adsorbing agents lowering the concentration of toxic substances in fermentation medium. Yeast

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hulls help alleviate stuck fermentations by acting as providers of unsaturated fatty acids and sterols (Munoz and Ingledew 1990).

Materials and methods

35 ^{o}Brix study Canandaigua Wine Company provided Chardonnay, Chenin Blanc, Sauvignon Blanc, and Rubired concentrates for the study. Each variety was reconstituted to 35 ^{o}Brix with distilled water. Two separate volumes of 1 L of each variety of reconstituted juice were inoculated with 17 x 106 cells/mL or 4 x 106 cells/mL of yeast strain L2226. Amounts of 200 mL of inoculated juice were placed in 8 tared erlenmeyer flasks for each variety with 3 boiling beads and yeast nutrients (see table 1).

Flasks were stoppered with a #6 rubber cork and a fermentation lock filled with 3 mL of SO_2. Corks were wrapped to the flask with parafilm. Flasks were placed on an orbital shaker at 100 rpm and weights were recorded every 48 hours until end of fermentation.

Table 1. Yeast Nutrient and Inoculation Rate

Flask #	inoculation (x 10^6)	DAP (g/L)	Fermaid (g/L)
1	17	2	2
2	17	0	0
3	17	0	2
4	17	2	0
5	4	2	2
6	4	0	0
7	4	0	2
8	4	2	0

Free alpha amino nitrogen (FAN) Fan levels in reconstituted and original juice were determined colorimetrically at 570 nm using the EBC ninhydrin method. Glycine was used to prepare the standard curve.

Results And Discussion Results of the 35 ^{o}Brix study showed that when alcohols were compared by inoculation levels across all treatments the 17 x 106 had a statistically significant greater alcohol level (16.65%) than the 4 x 106 (15.755%). Treatments were not significant for Chardonnay or Sauvignon Blanc and more replications are needed for Thompson Seedless. Chenin Blanc and Rubired mean alcohol values can be found in Tables 2 and 3. FAN results (see Table 4) showed that the loss of nitrogen in the reconstituted juice could impact the rate of fermentation if the juice is not supplemented with a nitrogen source.

Table 2. Chenin Blanc Mean Alcohol Values

Treatment			Alcohol (%)
I	F	D	
17	0	2	16.70 a
17	2	2	16.60 a
17	2	0	16.60 a
17	0	0	16.10 ab
4	2	0	15.90 bc
4	2	2	15.85 bc
4	0	2	15.65 bc
4	0	0	15.30 c

Table 3. Rubired Mean Alcohol Values

Treatment			Alcohol (%)
I	F	D	
17	2	2	16.50 a
17	2	0	16.15 a
17	0	2	15.90 a
17	0	0	15.75 ab
4	0	2	15.10 bc
4	2	2	14.80 c
4	0	0	14.40 cd
4	2	0	13.90 d

LSD=0.7727, I=inoculation (17 x 10^6 or 4 x 10^6), F=Fermaid (g/L)
D=diammonium phosphate (g/L).

Table 4. Free Amino Nitrogen Content of Juice and Reconstituted Juice (mg/L).

Grape Variety	Juice content	Reconstituted juice content
Sauvignon Blanc	208	177
Chenin Blanc	152	114
Chardonnay	195	161
Rubired	182	115

Conclusion High alcohol fermentations of grape juice concentrate are subject to many problems during the fermentation process. Concentrating units may deplete juice of important vitamins and minerals that can be supplemented with yeast nutrients and nitrogen sources. Alcohol concentrations of 16.7 to 13.9% were achieved with concentrates made with Evapor® system at different treatments. FAN analysis showed that reconstituted juice had somewhat lower levels of Nitrogen than did original juice. Grape juice concentrates made with Evapor® system can be successfully used for high alcohol fermentations.

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