Warren J. Baker Endowment
for Excellence in Project-Based Learning
Robert D. Koob Endowment *for Student Success*

FINAL REPORT

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I. Project Title

Malolactic Fermentation Sensor Development Project

II. Project Completion Date

March 1, 2017

III. Student(s), Department(s), and Major(s)

(1) Timothy Holst, Wine & Viticulture, Wine & Viticulture

(2) Braden Bautista, Wine & Viticulture, Wine & Viticulture

IV. Faculty Advisor and Department

Dr. Federico Casassa, Wine & Viticulture

V. Cooperating Industry, Agency, Non-Profit, or University Organization(s)

Cypress Semiconductor

VI. Executive Summary

Malolactic fermentation (MLF) is commonly carried out in winemaking as a tool for deacidification, altering the sensory profile and increasing the microbial stability of a wine. MLF must be monitored and sometimes stopped so as to prevent unwanted microbial spoilage. Current methods for monitoring MLF are both expensive and labor intensive and a low cost automated sensor could be of practical relevance for the wine industry. Due to the different densities of malic acid and lactic acid, density measurements could be used to monitor MLF. This multifaceted project involved two key studies, a study of density during MLF in a Zinfandel wine and a study of the pressure tube density meter during MLF. The goal of the study of density during MLF in a Zinfandel wine was to determine if a correlation between malic acid concentration and density exists and to write a predictive curve which can be used to determine malic acid concentration from density measurements. The goal of the study of the pressure tube density meter during MLF was to assess the sensitivity, compatibility and potential for adapting the pressure tube technology used in Cypress

Semiconductor's Integrated Fermentation Control System (IFCS) to monitor malic acid concentration during MLF with a density derived predictive curve. Daily samples were taken from three replicate 208 Liter fermenters and analyzed for density and L-malic acid concentration in a laboratory setting for the duration of MLF of a Zinfandel wine. The regression models fit to the data did not show evidence of a correlation between malic acid concentration and density with the coefficient of determination for each fermenter being $R_{2Tank}1 = 0.01092$, $R_{2Tank2} = 0.00085$, $R_{2Tank3} = 0.01826$ and $R_{2Tank\_all} = 2.082\text{-}5$. The high standard deviations in density for each data set ($SD_{Tank1} = 0.0051$, $SD_{Tank2} = 0.0038$, $SD_{Tank3} = 0.0046$ and $SD_{Tank\_all} = 0.0045$) implied a lack of sensitivity in testing methodology due to a volumetric variation not accounted for in density calculations. The data collection software disconnected from the IFCS units during alcoholic fermentation, halting data collection. Without data collection, it was impossible to assess the capabilities of the IFCS as a MLF sensor.

VII. Major Accomplishments

(1) A large quantity of data was collected on the effects of malolactic fermentation on the density of a wine for the duration of malolactic fermentation, which has not previously been studied to such extensity.

(2) New information was collected on the proper use of the Integrated Fermentation Control System and how to ensure its reliability throughout a fermentation.

(3) Logistics for the use of the Integrated Fermentation Control System in a production winery during harvest were explored. This information can aid in the commercialization of the system.

VIII. Expenditure of Funds

Funds were originally expected to be spent primarily on grapes, however, 0.5 Tons of Zinfandel was donated to the project. The primary expenditure of the project was instead the transportation of the research fermenters and IFCS units, which totaled around $586. The other expenditure of the project was on an enzymatic assay kit for measuring L-malic acid concentration, which totaled around $230.

IX. Impact on Student Learning

This project was extremely educational in teaching about how to carry out research projects. Despite meticulously planning the many steps of this project and paying great attention to detail during the project, some pieces of the study were did not go according to plan. Harvest is very busy without attempting to complete research. There were logistical concerns stemming from harvest conditions which I had not previously considered. This project also highlighted the importance of finding the successes and learning in a project which does not necessarily yield the desired results.

Advanced technologies such as the IFCS are not common in wineries or agriculture in general. It was very beneficial to see an advanced technology in the winery setting. Agriculture tends to be slow to adopt new technologies. Working with the technology during harvest helped

me to understand why there is a slow adoption rate to new technologies. I also gained a more extensive understanding of the potential for how helpful new technologies in the winery could be.

The knowledge I gained from this project will be incredibly valuable if I continue to work on this project in the future. After completing this stage of the project, I continue to believe developing a sensor using the density method is entirely possible using the pressure tube density meter in the IFCS. Using what was learned with this project, it is possible to design a better study which could yield different results than the results found in this project. Completing this study during harvest also helped in exploring the practical application of a density based MLF sensor in a production winery. - Timothy Holst