Final Report

Continued investigation of novel maceration techniques to improve Pennsylvania wine quality

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Objective, Project Overview, and Goals

The project proposed was a multi-year study that would investigate the use of a variety of novel macerations treatments applied to white hybrid grapes (Cayuga and Traminette) and access the effects each treatment has on phenolic extraction, antioxidant capacity, and aroma quality. Our first objective was to access to applicability and feasibility of using different cryogens (liquid nitrogen **(LN)**) and dry ice) applied through alternative delivery systems for rapid cryogenic maceration during oxidative and reductive winemaking procedures. Our second objective was to investigate the effect of freezing rate in the form of rapid cryogenic maceration **(CR-R)** using a cryogen, versus slow cryogenic maceration **(CR-S)** using static freezing with respect to wine quality and stability. Our third objective is to compare cryogenic maceration with short duration cold soak **(CS)** (skin contact) with respect to final wine quality and stability.

Current Results and Status of Project

As of 20 March 2020, we have completed two years (2018 and 2019) of experimental winemaking from two separate vineyards sites located in Centre County and Erie County Pennsylvania. Both vintages produced wines from the white fleshed interspecific hybrid grape (*Vitis ssp.*) varieties Cayuga and Traminette. In 2018 rapid and slow cryogenic maceration treatments were applied to Cayuga and Traminette grapes using liquid nitrogen and static freezing applied directly to crushed and destemmed grape must inside of grape must collection vessels. Samples of juice were collected post treatment for analysis and micro-fermentations were performed in triplicate replicates for each treatment group. Samples of juice and wine were analyzed for conventional analysis including total soluble solids (TSS), titratable acidity (TA), pH, volatile acidity (VA), and ethanol content (%v/v) using standard protocols. Browning was measured by absorbance at 420 nm using a UV/vis spectrophotometer. Wine and juice tristimulus color was obtained by full spectrum scanning in transmittance mode from 380 nm to 780 nm at 5 nm increments followed by integration utilizing the method set forth in the Compendium of International Methods of Wine and Must. From this integration the values of Clarity (L^*), red/green color component (a^*), yellow/blue color component (b^*), Chroma (C_{ab}), Hue (H_{ab}), overall color difference between wines (ΔE_{ab}), and difference in tone (hue) between two wines (ΔH_{ab}). Total phenolic content was analyzed by Folin-Ciocalteu assay on triplicate juice and wine samples and reported in mg/L gallic acid equivalents. Antioxidant capacity was determined on triplicate juice and wine samples using the DPPH radical scavenging assay and reported in mg/L Trolox equivalents. Wine aroma profiling was performed in duplicate on triplicate wine samples using headspace solid-phase microextraction coupled with gas chromatography-mass spectrophotometry (HS-SPME/GCMS). This highly sensitive method allowed for the separation of volatile aromatic compounds within wine samples. These aroma

compounds were then grouped as methyl and ethyl esters, acetate esters, volatile fatty acids, higher alcohols, aldehydes and quantified as concentration in relative abundance of internal standards. Iron speciation analysis was performed using a spectrophotometric method to determine ratios of reduced iron (Fe^{2+}) to (Fe^{3+}) and total iron in an effort to evaluate the redox capacity of the finished wines as a greater ration of Fe^{2+} to Fe^{3+} is indicative of less oxidation having taken place and a greater redox potential. Tannin analysis was performed using the Harbertson-Adams assay to measure protein-tannin interactions using bovine serum albumin (BSA) to precipitate tannins from a wine sample. The specific individual phenolics: (+)-catechin, (-)-epicatechin, and gallic acid were determine by duplicate injections of triplicate wine and juice samples using HPLC coupled with a UV/Vis detector. The determination and quantification of these phenolic compounds give a greater picture of the extraction profile for where in the grape berry the majority of phenolics are being extracted during treatment. Glutathione (GSH) which is an extremely important tripeptide of L-glutamate, L-cysteine, and glycine due to its redox activity and antioxidative properties is currently in the stages of analytical method developed and will be analyzed in the near future using HPLC coupled with electron capture detection (ECD). A descriptive analysis (DA) sensory panel was conducted on the 2019 wines. This panel of 9 participants (n=9) was trained three days a week over the course of 2.5 months focusing on specific attributes observed in the sample wines in terms of appearance, aroma, taste, mouthfeel, and flavor.

Objective 1: Applicability of different cryogens (liquid nitrogen and dry ice) applied through alternative delivery systems for rapid cryogenic maceration during oxidative and reductive winemaking procedures.

Background & Rationale: Typically white wines are low in phenolic substances and antioxidative capacity and research in this area tends to focus heavily on white *Vitis vinifera* varieties while lacking in white interspecific hybrid (*Vitis ssp.)* varieties. In Pennsylvania, the need for durable, disease, and weather resistant grape varieties has led to increased interest in expanding plantings of interspecific varieties. However, compared to their *vinifera* counterparts, hybrid varieties have been stigmatized as uninteresting, boring, devoid of aromatic and flavor complexities, and sometimes exhibiting undesirable aroma and flavor components. This is why it is paramount to investigate cost effective and applicable technologies and methods for small scale wineries to enhance and retain desirable aromatic compounds that are paramount to white wine quality and consumer liking. A major contributor to aromatic quality in white wine is due to the degree of ripeness of grapes achieved during the growing season. Maximizing optimal ripeness in grapes grown throughout the Northeastern United States is a challenging and highly varied process due to the high degree of variation in weather patterns and the length of the growing season. This leads to inconsistencies in the final degree of ripeness and a disparity in aromatic development. The use of rapid rate cryogenic maceration **(CR-R)**, slow rate cryogenic maceration **(CR-S)**, and short duration cold soaking **(CS)** during winemaking can aid the extraction of beneficial phenolic and chemical constituents that could possibly prevent quality and stability degradation and enhance aroma and flavor development. Since current literature in this area predominantly pertains to *Vitis vinifera* wines and Interspecific hybrid grapes differ compositionally and chemically, more in-depth research into how these various maceration treatments will effect winemaking parameters and subsequently effect overall quality and stability in white hybrid wines is needed.

Results: The 2018 vintage was conducted as a small pilot study to investigate the use of liquid nitrogen delivered through a diffuser type injection system. The liquid nitrogen supplied from a dewar was transferred through a stainless steel hose that was fitted with a metal coiled diffuser designed to be inserted into the bottom of a grape must collection vessel. The liquid nitrogen was then injected into the bottom of the collection vessel and allowed to rapidly disperse through the must. This allowed for the rapid chilling (< 15 minutes) of the must from 4°C to -10°C. However due the cumbersome nature, high cost of a LN dewar and the tendency for the holes in the diffuser to clog during freezing made rapid and efficient must to must transfer difficult. Additionally an LN blanket does not tend to remain in surface

contact with must for very long and oxidation becomes a primary concern as oxidation in aromatic white wines is a highly influential variable in determining final wine quality and acceptability. Since controlling oxidation for this study is paramount, a new design was approached for the 2019 vintage. The delivery system was simplified and the collection vessel changes and a more reductive winemaking procedure adopted. Liquid nitrogen (**LN)** was replaced with dry ice (solid CO_2) as it sublimes at ambient temperatures normal atmospheric pressure. This allows for the continuous generation and layering of CO_2 gas which helps to continuously displace oxygen from the must/juice surface helping to prevent oxidation. The collection vessel was changed to a food grade double lined plastic bag equipped with valves that are interchangeable with standard stainless steel valves, clamps, and rubber gaskets commonly used throughout the wine industry. This new system allowed for better retainment of inert gas and displacement of oxygen. The bags were also able to be evacuated of air and sealed to the surface of the must/juice allowing for displacement of oxygen and preservation of the must/juice. Additionally, all pressing operation and juice transfers were able to be conducted inside of these bags which greatly reduced contact with oxygen. All maceration treatment for the 2019 vintage were conducted inside of these bags in order to monitor the effects of the bags themselves on final wine quality and stability irrespective of treatment. The preliminary results from the new experimental design in 2019 show greater control and consistency across finished wine replicates over all treatments.

Objective 2: Investigate the effect of freezing rate in the form of rapid cryogenic maceration (CR-R) using a cryogen, versus slow cryogenic maceration (CR-S) using static freezing with respect to wine quality and stability.

Background & Rationale: Cryogenic maceration is a novel maceration technique that involves the freezing of the grape must post destemming and crushing using some type of cryogen. The colder temperatures is believed to minimize the loss of volatile and/or oxidatively labile aroma compounds and increase the extraction of phenolic compounds. This technique has been previously shown to generate significant benefits in white wine production while reducing negative effects on the sensory attributes of a wine. Prior research has shown increased levels of phenolics, varietal aroma compounds, and antioxidant capacity in whites wines typically associated with low levels of anti-oxidant capacity and low-level resistance to in-bottle oxidation. Cryogenic maceration causes disruption of the cell wall of grapes through the formation of ice crystals. The rate of freezing has a substantial effect on the quality, chemical and physical attributes of the thawed product. The more rapid the rate of freezing results in smaller more uniform ice crystals compared to slower rate freezing which generates larger and non-uniform ice crystals thus causing even greater disruption of the grape cell wall. This cellular disruption allows for increased juice yield and enhanced phenolic extraction compared to typical white wine processing techniques. Another benefit of the rapid cryogenic maceration is a by-product of the use of dry ice (solid carbon dioxide) or liquid nitrogen as the cryogen which displaces oxygen when they turn into a gas during the freezing process. This protects the must and wine from reactive oxygen species and prevents them from reacting with the extracted phenolics, allowing for their preservation in the final wine. Alternatively slow rate freezing does not employ the use of these cryogens so the musts must be blanketed with inert gas (argon, nitrogen, carbon dioxide) and sealed during the 6 to 8 hour freezing process to prevent oxidation. A potential downside of slow rate freezing is the potential for increased rates of enzymatic oxidation that can lead to extensive browning and loss of oxidatively labile aroma compounds due to increased cellar damage and longer exposure time to oxygen during the freezing and thawing process compared to CR-R.

Results: White flesh interspecific hybrid (*Vitis ssp.*) Cayuga and Traminette grapes from the Centre County region of Pennsylvania were hand harvested (300 lbs. each) and transported to the Wet Pilot Plant (**WPP**) in the Department of Food Science at The Pennsylvania State University. All grapes were than chilled overnight in the WPP walk-in refrigerator to chill grapes to 4°C prior to processing. Characteristics of the 2018 Cayuga grapes pre-processing were total soluble solids (TSS) 15.2°Brix, pH 3.23, and a total acidity (TA) 7.9 g/L. Characteristics of the 2018 Traminette grapes pre-processing were

TSS 16.0°Brix, pH 3.08, and a TA 9.1 g/L. Three winemaking procedures were applied to each grape variety as triplicate juice and fermentation replicates as follows:

- Control (C) – whole cluster fruit was crushed and de-stemmed, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite and then immediately pressed using a 40 L stainless steel hydraulic basket press. Juice was cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.
- Rapid Cryogenic Maceration (CR-R) – whole cluster fruit was crushed and de-stemmed, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite. Liquid nitrogen was injected into grape must and reduced must temperature from 4°C to -10°C and a semi-solid state in < 15 minutes. Grape must was then placed in WPP walk-in freezer at -20°C overnight. Frozen grape must was then thawed at ambient temperature and pressed using a 40 L stainless steel hydraulic basket press. Juice was cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.
- Slow Cryogenic Maceration (CR-S) – whole cluster fruit was crushed and de-stemmed, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite. Grape must was sealed in collection vessels under nitrogen gas (N_2) and placed in the in WPP walk-in freezer at -20°C overnight. Grape must temperature was reduced from 4°C to -10°C in 8 hours. Frozen grape must was then thawed at ambient temperature and pressed using a 40 L stainless steel hydraulic basket press. Juice was cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.

Post fermentation, wines were cold settled at 4°C for 48 hours and then racked off of gross lees and 30 mg/L SO_2 was added to each wine. Wines were then cold stabilized for 21 days at 4°C and subsequently racked and 20 mg/L SO_2 was added prior to bottling in 375 ml glass bottles sealed with aluminum (Stelvin Closure) screw top closures. Wines were then stored at 4°C. Juice samples were collected and analyzed from post-press fractions prior to fermentation. Wine samples were collected and analyzed post bottling and additional samples of juice and wine were frozen at -80°C for future analysis.

Conventional analysis of juice and wine from 2018 Cayuga **Table 1** and 2018 Traminette **Table 2**. 2018 Cayuga and 2018 Traminette both exhibit an increase in pH from pre-treatment to post treatment juice with significant differences in pH observed in Traminette post-treatment juice. Alternatively decreases in TA are not observed for control (C) but are observed in rapid cryogenic maceration (CR-R) and slow cryogenic maceration (CR-S). The pH increased in Cayuga juice, the pH returned to normal white wine ranges in the final wine and remained significantly higher in the CR-R and CR-S wines compared to the control, but still remained in a suitable range for white wine production. The pH increased in Traminette juice across all treatment groups and decreased in wines. However only the control Traminette wine returned to a suitable white wine pH while the CR-R and CR-S wine pH remained at an unstable level for white wines. The TA for the CR-R and CR-S Cayuga and Traminette wines showed significant reductions compared to the control wines. The absorbance values at 420 nm, Cayuga **Table 1** and Traminette **Table 2**, which is an indicator of browning showed significant increases in the browning of the CR-R and CR-S juice compared to the control for both varieties. This increase in browning at the juice stage does not translate to finished wine as no significant differences are observed between the C, CR-R, and CR-S and 420nm values return to a normal range. However, although not statistically significant, the absorbance at 420nm is slightly higher in the CR-S wine compared to control. This increased in browning in the juice which results in lighter colored wines could be the result of non-enzymatic browning due to presence of SO_2 in the must which would cause the removal of phenolics by precipitating them out thus reducing the phenolic browning capacity in the finished CR-R and CR-S wine.

Table 1: Juice and wine conventional analysis of 2018 Cayuga for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values are shown ± 1 SD of the mean, and results in the same column with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Cayuga					
Juice	**pH**	**TA (g/L)**	**VA (g/L)**	**A_{420}**	**Brix**
C	3.52 ± 0.01^{a}	7.22 ± 0.34^{a}	0.03 ± 0.00^{a}	0.024 ± 0.004^{b}	15.1 ± 0.12^{b}
CR-R	3.54 ± 0.02^{a}	7.13 ± 0.39^{a}	0.02 ± 0.00^{b}	0.174 ± 0.031^{a}	15.7 ± 0.15^{a}
CR-S	3.53 ± 0.01^{a}	6.92 ± 0.18^{a}	0.03 ± 0.00^{a}	0.154 ± 0.022^{a}	15.7 ± 0.10^{a}
Wine	**pH**	**TA (g/L)**	**VA (g/L)**	**A_{420}**	**ABV %**
C	3.31 ± 0.02^{b}	6.77 ± 0.12^{b}	0.04 ± 0.01^{a}	0.044 ± 0.000^{a}	9.0 ± 0.09^{a}
CR-R	3.44 ± 0.01^{a}	7.07 ± 0.06^{a}	0.02 ± 0.00^{b}	0.047 ± 0.003^{a}	8.5 ± 0.12^{b}
CR-S	3.45 ± 0.01^{a}	6.98 ± 0.03^{a}	0.03 ± 0.00^{ab}	0.048 ± 0.005^{a}	8.7 ± 0.18^{b}

Table 2: Juice and wine conventional analysis of 2018 Traminette for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values are shown ± 1 SD of the mean, and results in the same column with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Traminette					
Juice	**pH**	**TA (g/L)**	**VA (g/L)**	**A_{420}**	**Brix**
C	3.33 ± 0.01^{b}	9.09 ± 0.83^{a}	0.01 ± 0.00^{a}	0.105 ± 0.024^{c}	15.9 ± 0.12^{b}
CR-R	3.70 ± 0.02^{a}	8.26 ± 0.14^{a}	0.00 ± 0.00^{a}	0.674 ± 0.070^{a}	16.4 ± 0.06^{a}
CR-S	3.68 ± 0.02^{a}	7.86 ± 0.56^{a}	0.00 ± 0.00^{a}	0.503 ± 0.042^{b}	16.3 ± 0.12^{a}
Wine	**pH**	**TA (g/L)**	**VA (g/L)**	**A_{420}**	**ABV %**
C	3.18 ± 0.02^{b}	8.33 ± 0.15^{a}	0.04 ± 0.00^{a}	0.068 ± 0.000^{a}	9.0 ± 0.09^{a}
CR-R	3.59 ± 0.00^{a}	7.90 ± 0.00^{b}	0.03 ± 0.01^{a}	0.098 ± 0.003^{a}	8.6 ± 0.15^{b}
CR-S	3.61 ± 0.02^{a}	7.90 ± 0.17^{b}	0.03 ± 0.00^{a}	0.122 ± 0.039^{a}	8.5 ± 0.12^{b}

Tri-stimulus (CIE-Lab) colors results for 2018 Cayuga juice and wine are found in **Table 3.** The most significant findings were observed in the CIE-Lab values for the juice as statistically significant differences were observed between treatments and the control. CR-R and CR-S juice appeared browner compared to the control juice. The CR-R and CR-S juice showed a decrease in lightness L^*, an increase in red color (positive a^*), an increase in yellow color (positive b^*), increase in chroma C^*_{ab} and lower in hue H_{ab}, compared to control juice. The increase in a^* and b^* in CR-R and CR-S juice indicates browning which may be the result of phenolic oxidation coupled with polymerization and precipitation of large polymeric pigments compared to control wine. Increase in C^*_{ab} values in CR-R and CR-S juice are indicative of greater color saturation and decreases in H_{ab} values are indicative of a darker hue both indicating browning. However, the finished wines show no significant difference between C, CR-R, and CR-S wines and CIE-Lab values show no signs of browning or oxidation in finished wines.

Table 3: CIE-Lab color values observed from 2018 Cayuga juice and wine for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values

are shown ± 1 SD of the mean, and results in the same row with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Cayuga			
Juice Values	**C**	**CR-R**	**CR-S**
L*	99.5 ± 0.2a	93.9 ± 0.6b	94.7 ± 0.7b
a*	-0.20 ± 0.02b	0.54 ± 0.47ab	0.65 ± 0.35a
b*	1.41 ± 0.27b	8.54 ± 1.44a	7.67 ± 1.12a
C^*_{ab}	1.42 ± 0.27b	8.57 ± 1.44a	7.70 ± 1.13a
H_{ab}	98.2 ± 0.9a	86.4 ± 3.4b	85.2 ± 2.4b
Wine Values	**C**	**CR-R**	**CR-S**
L*	99.2 ± 0.1[a]	99.1 ± 0.3[a]	99.1 ± 0.2[a]
a*	-0.10 ± 0.12[a]	-0.11 ± 0.04[a]	0.02 ± 0.15[a]
b*	3.03 ± 0.06[a]	3.37 ± 0.09[a]	3.43 ± 0.29[a]
C^*_{ab}	3.04 ± 0.06[a]	3.37 ± 0.09[a]	3.43 ± 0.29[a]
H_{ab}	91.8 ± 2.3[a]	92.0 ± 0.7[a]	89.8 ± 2.3[a]

Changes in CIE-Lab color parameters observed between treatments in 2018 Cayuga juice and wine are found in **Table 4.** The CR-R and CR-S juice and wine treatments were compared to the control juice and wine. The negative ΔL* values indicate the CR-R and CR-S were much darker compared to the control juice. Although the ΔL* values for CR-R and CR-S wines are negative, their values (-0.03 and -0.03) are essentially zero indicating no difference in lightness of either treatment wine compared to the C wine. Positive Δa* values indicate more red color and negative values corresponding to more green color. CR-R and CR-S juice show a similar magnitude of increase in red color compared to the control juice with the CR-S wine having an increase in red color compared to control wine, whereas the CR-R wine shows slightly more green color compared to the control wine. Positive Δb* values indicate more yellow color and negative values indicate more blue color. The large positive Δb* values for the CR-R and CR-S juice indicates significant increase in yellow color and when coupled with the magnitude of the positive Δa* values of CR-R and CR-S juice indicates significant browning compared to the control. While the positive Δb* values for the CR-R and CR-S wines indicate more yellow color compared to the control wine, the low magnitude of these values indicate that the browning observed in the juice does not translate to the finished wine. However the CR-S wine does maintain slightly higher positive Δa* and Δb* values indicating that the CR-S treatment was more orange compared to either the C or CR-R wines. ΔE^*_{ab} indicates overall color difference between treatment wines and control wines. The greater ΔE^*_{ab} values observed in the CR-R and CR-S juice indicates significant variability in color between the CR-R and CR-S juice compared to the C. Alternatively there appears to be no difference in color between the CR-R and CR-S wines and only a minimal if any color difference in CR-R and CR-S wines compared to the C wine. ΔH_{ab} values for the CR-R and CR-S juice indicate a darker hue compared to the C juice. ΔH_{ab} values for the CR-R and CR-S wines indicate a tiny difference in hue compared to C wines.

Table 4: Changes in CIE-Lab color parameters observed between 2018 Cayuga juice and wine in comparing the maceration treatments: rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S) to the control (C).

	2018 Cayuga Juice	**2018 Cayuga Wine**

CIE-Lab Parameter	CR-R	CR-S	CR-R	CR-S
ΔL*	-5.54	-4.73	-0.03	-0.03
Δa*	0.74	0.85	-0.02	0.12
Δb*	7.13	6.25	0.33	0.39
ΔC^*_{ab}	7.15	6.27	0.33	0.39
ΔE^*_{ab}	9.06	7.88	0.39	0.41
ΔH_{ab}	0.51	0.69	0.21	0.12

Tri-stimulus (CIE-Lab) colors results for 2018 Traminette juice and wine are found in **Table 4.** The most significant findings were observed in the CIE-Lab values for the juice as statistically significant differences were observed between treatments and the control. CR-R and CR-S juice appeared significantly browner compared to the control juice. The CR-R and CR-S juice showed a significant decrease in lightness L^*, an increase in red color (positive a^*), an increase in yellow color (positive b^*), increase in chroma C^*_{ab} and lower in hue H_{ab}, compared to control juice. The large increase in a^* and b^* in CR-R and CR-S juice indicates browning which may be the result of phenolic oxidation coupled with polymerization and precipitation of large polymeric pigments compared to control wine. Increase in C^*_{ab} values in CR-R and CR-S juice are indicative of greater color saturation and decreases in H_{ab} values are indicative of a darker hue both indicating browning. Compared to Cayuga juice, Traminette shows significantly more browning, which can be expected as Traminette juice is highly susceptible to oxidation compared to other varieties. The additional color may also be due to the nature of Traminette and its Gewurztraminer parentage which produces berries with pink to reddish color skin and can contribute additional color to juice and wine depending on winemaking parameters. Finished CR-R and CR-S wines show no significant difference in lightness L^* compared to C wine. Statistically there is no significant different in red/green color a^*, however looking at **Table 5** it can be observed that the CR-S wines exhibit more red color compared to the CR-R and C wines which exhibit more green color. CR-S wine also show a statistically significant increase in yellow color b^* and chroma C^*_{ab} compared to C wines while no statistically significant difference is observed between the CR-R and C wines. Additionally a significant difference in hue H_{ab} is observed between the CR-S and C wines but not observed between the CR-R and C wines. This indicates additional color present in the CR-S wines compared to the CR-R and C wines and coupled with absorbance values at 420 nm for the CR-S wines in **Table 2** would indicate some browning from oxidation has carried over from the juice. This may be the result of the longer exposure time of must to air during the slow freezing and thawing process.

Table 5: CIE-Lab color values observed from 2018 Traminette juice and wine for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values are shown ± 1 SD of the mean, and results in the same row with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Traminette			
Juice Values	**C**	**CR-R**	**CR-S**
L*	96.9 ± 0.9^a	89.2 ± 2.4^b	90.9 ± 1.1^b
a*	-0.15 ± 0.09^b	1.49 ± 0.63^a	1.09 ± 0.27^a
b*	5.12 ± 1.00^b	21.29 ± 1.36^a	18.99 ± 1.76^a

C^*_{ab}	5.12 ± 1.00^b	21.35 ± 1.39^a	19.02 ± 1.77^a
H_{ab}	91.9 ± 1.3^a	86.1 ± 1.5^b	86.7 ± 0.5^b
Wine Values	**C**	**CR-R**	**CR-S**
L*	98.7 ± 0.3^a	98.4 ± 0.2^a	98.0 ± 1.1^a
a*	-0.30 ± 0.05^a	-0.11 ± 0.06^a	0.27 ± 0.59^a
b*	4.18 ± 0.19^b	6.21 ± 0.46^{ab}	8.02 ± 2.59^a
C^*_{ab}	4.20 ± 0.19^b	6.21 ± 0.46^{ab}	8.03 ± 2.62^a
H_{ab}	94.0 ± 0.5^a	91.1 ± 0.7^{ab}	88.8 ± 3.3^b

Changes in CIE-Lab color parameters observed between treatments in 2018 Traminette juice and wine are found in **Table 6.** The CR-R and CR-S juice and wine treatments were compared to the control juice and wine. The treatment juice and wine show similar trends as observed by the CIE-Lab color values in **Table 5.** The juice of the CR-R and CR-S treatments show large changes compared to C juice observed by increases in darkness L^*, red color a^*, yellow color b^*, and chroma C^*_{ab} indicative of significant browning and phenolic oxidation. Greater ΔE^*_{ab} values in CR-R and CR-S juice show significant variability in color compared to C juice. Despite large changes in CIE-Lab color parameters observed in the juice, these changes are minimal in the CR-R and CR-S wines compared to C wine. However, compared to changes observed in 2018 Cayuga wine these changes are quite large indicating the potential of greater oxidation, phenolic browning, and extraction of color from the darker colored skins of Traminette. **Table 6** also shows that the change in CIE-Lab color parameters of CR-R and CR-S is greater in the CR-S wines when compared to the C wine. This trend was also observed in the CR-S 2018 Cayuga wines but is observed to a greater extent in the Traminette CR-S wines. The greater ΔE^*_{ab} indicate color variability in the CR-R and CR-S wines compared to C wine but a higher color variability between the CR-S and C wines.

Table 6: Changes in CIE-Lab color parameters observed between 2018 Traminette juice and wine in comparing the maceration treatments: rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S) to the control (C).

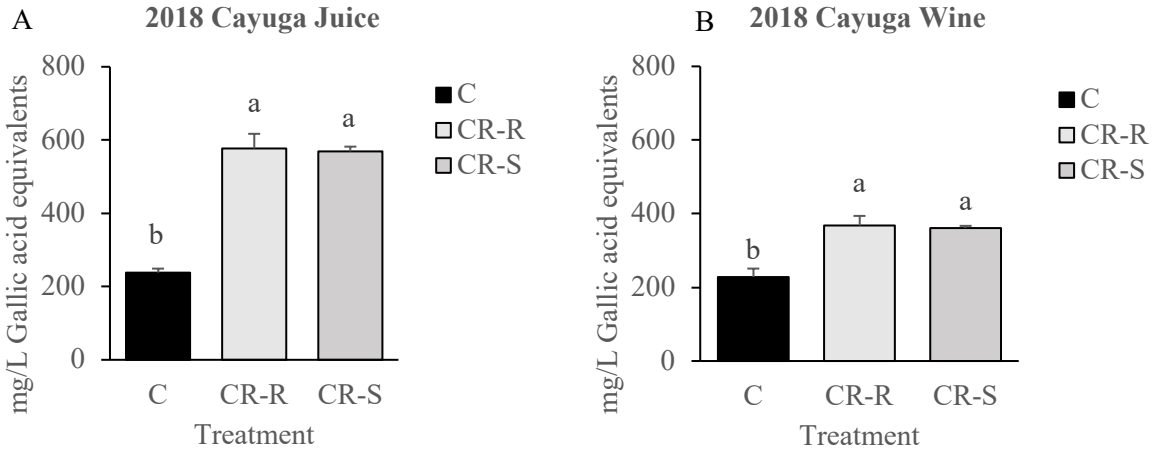
CIE-Lab Parameter	2018 Traminette Juice		2018 Traminette Wine	
	CR-R	CR-S	CR-R	CR-S
ΔL^*	-7.7	-6	-0.23	-0.65
Δa^*	1.64	1.24	0.18	0.57
Δb^*	16.17	-2.30	2.03	3.83
ΔC^*_{ab}	16.23	13.90	2.02	3.83
ΔE^*_{ab}	17.98	15.16	2.05	3.93
ΔH_{ab}	0.76	0.78	0.26	0.57

The results for total phenolic analysis by Folin-Ciocaultau assay for 2018 Cayuga and Traminette wine and juice are found in **Figure 1.** A significant increase in phenolics was observed in both the CR-R and CR-S juice compared to the C juice of CR-R (58.7%) and CR-S (58.2%). This increase in phenolics was maintained in the CR-R (38.0%) and CR-S (36.84%) wines compared to the C wine. There was no significant change in total phenolics between C juice and C wine. However, a large decrease in phenolics

was observed from between CR-R and CR-S juice and wine. This large decrease in phenolics could be due to polymerization of phenolics causing large polyphenolics to precipitate out of solution thus decreasing the total concentration of phenolics in finished CR-R and CR-S wines.

The same trend in total phenolic extraction is observed in the 2018 Traminette juice and wine as observed in 2018 Cayuga. However, the total concertation of total phenolics is lower in Traminette across all treatments compared to Cayuga. This is to be expected as differences in total phenolic content exist between different grape varieties and Cayuga has been shown to contain greater quantities of extractable phenolic material compared to Traminette. A lesser increase in total phenolics was observed in CR-R (22.3%) and CR-S (20.5%) juice compared to C juice. The total phenolic content of CR-R and CR-S wines was significantly higher than the C wine and both the CR-R and CR-S wines maintained their concentration of phenolics from juice to wine, whereas a large decrease in total phenolic content was observed from the C juice to the C wine.

The total phenolic content of 2018 Cayuga and Traminette showed significant increase in both across juice and wine. This is to be expected, as previous studies have shown that the cellular disruption of plant tissues caused by cryogenic macerations is an effective tool for the non-ethanol based extraction of phenolics from grape skins and seeds. The increased total phenolic content has also been shown to be correlated with increase resistance to oxidation.



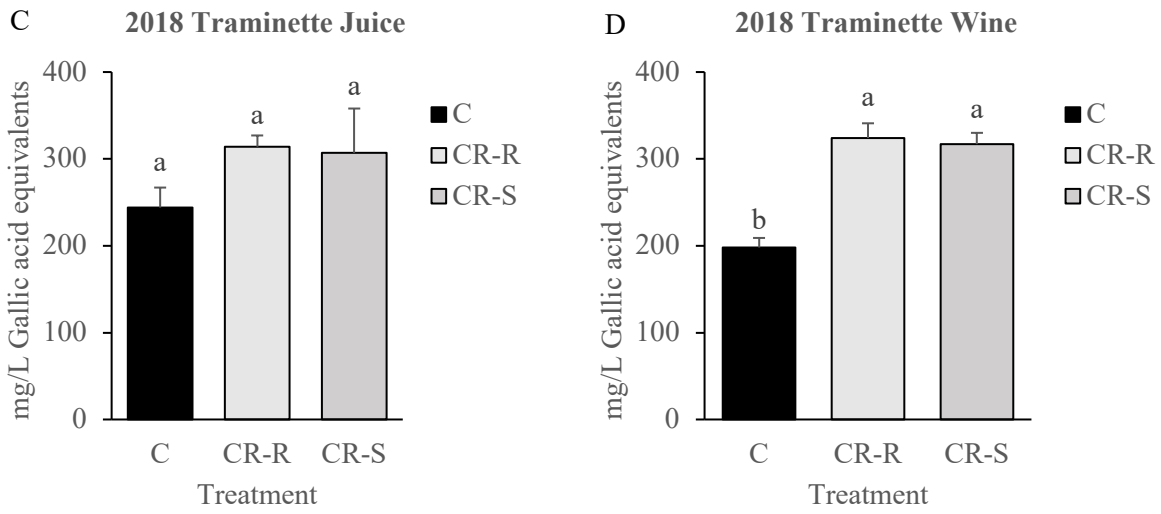


Figure 1: Total phenolic content as measured by Folin-Ciocaultau, expressed as mg/L Gallic acid equivalents, for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S), for A) 2018 Cayuga juice; B) for 2018 Cayuga wine; C) for 2018 Traminette juice; D) for Traminette wine. Error bars represent ± 1 SD of the mean, and results with different letters (a, b) are significantly different ($p < 0.05$).

The results for antioxidative capacity by DPPH radical scavenging assay for 2018 Cayuga and Traminette wine and juice are found in **Figure 2.** The results of the DPPH assay helps to quantify a wines potential for resistance to oxidation. There were significant differences observed in both CR-R and CR-S Cayuga juice and wine compared to the C juice and wine. This difference was observed as a 26.1% (CR-R) and 22.4% (CR-S) increase in antioxidative capacity of the juice compared to the C. This increase in antioxidative capacity observed in the juice was maintained in the CR-R and CR-S wines compared to the C wine.

There was no statistically significant difference observed between 2018 Traminette juice treatments although a 14.0% increase in antioxidative capacity was observed in CR-R juice compared to C juice compared to a marginal increase of 3.87% in antioxidative capacity observed in CR-S juice compared to C juice. However, there is a large significant difference between the antioxidative capacity of CR-R and CR-S wines compared to C wine. A large decrease in antioxidative capacity from 571 ± 94 Trolox equivalents in C juice to 408 ± 18 Trolox equivalents in C wine. The opposite was observed with an increase in antioxidative capacity from the CR-R and CR-S juice to wine. This resulted in an overall increase of 45.7% (CR-R) and 45.2% (CR-S) antioxidative capacity as Trolox equivalents in the CR-R and CR-S wines compared to C wine.

The increases in antioxidative capacity observed in the treatment wines between both varieties can be expected because of significant increase in total phenolics observed in **Figure 1.** These results would indicate that both maceration treatments have a significant impact on the extraction of total phenolics and subsequent increase in antioxidative capacity. This could have resulted from the browning out of unstable phenolic material in the treatment juice resulting in more oxidatively stable wines. Additionally, there is a larger degree of antioxidative capacity in the Cayuga wine compared to the Traminette which correlates to the amount of total phenolics in both wines. This helps to identify how differences in grape composition between varieties can have significant effects on final wine relative to winemaking practices.

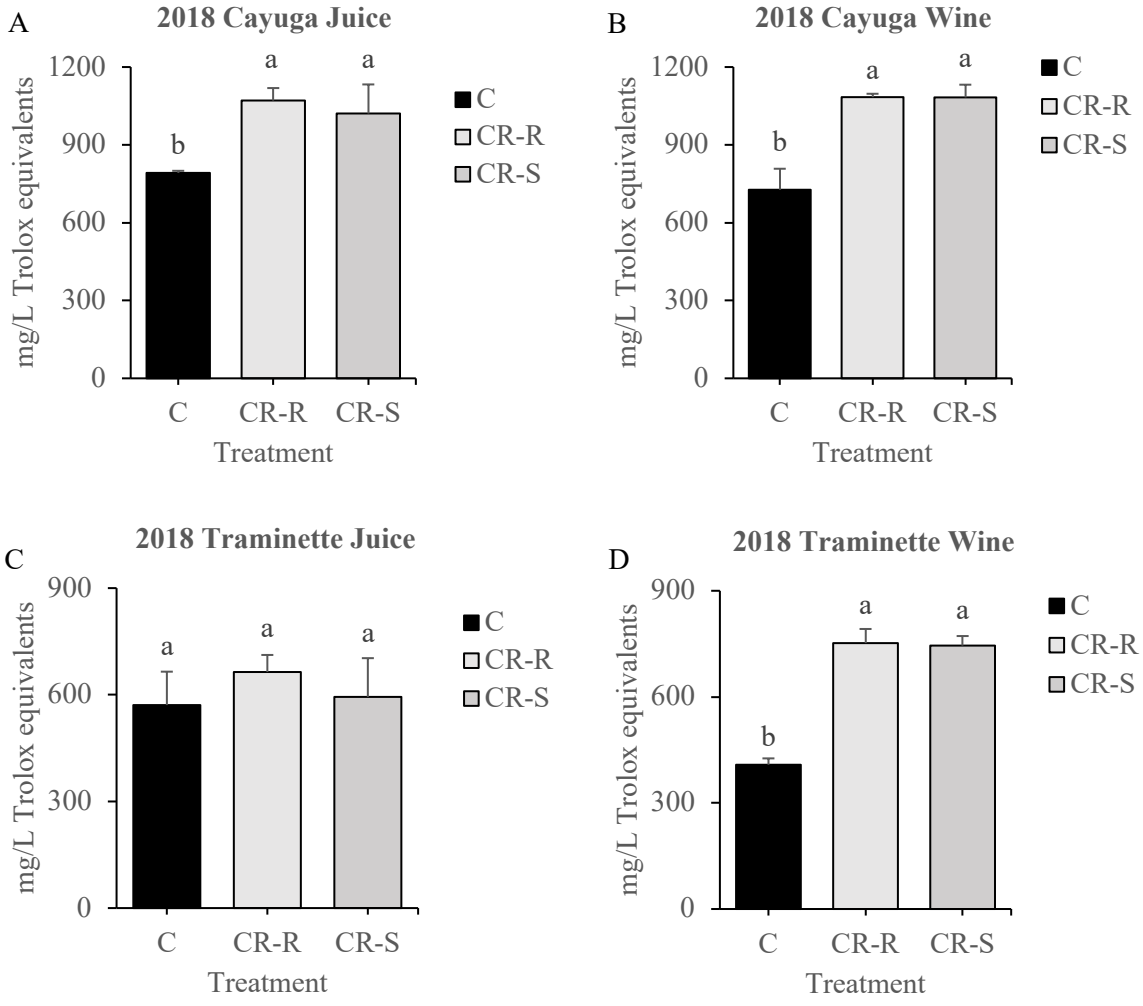


Figure 2: Antioxidant capacity as measured by DPPH, expressed as mg/L Trolox equivalents, for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S), for A) 2018 Cayuga juice; B) for 2018 Cayuga wine; C) for 2018 Traminette juice; D) for Traminette wine. Error bars represent ± 1 SD of the mean, and results with different letters (a, b) are significantly different ($p < 0.05$).

Table 7: Wine aroma profiling by HS-SPME/GCMS color observed from 2018 Cayuga wine for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values are shown ± 1 SD of the mean, and results in the same row with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Cayuga Wine Aroma Profiling HS-SPME-GC/MS								
Acetate Esters	**CAS**	**Mass**	**RT** (min)	**RI** (experimental)	**C**	**CR-R**	**CR-S**	**Odor Description**
Isobutyl acetate	110-19-0	116	3.85	1005	0.18 ± 0.02a	0.19 ± 0.01a	0.17 ± 0.02a	fruity, banana,sweet

3-Hexen-1-ol, acetate, (Z)-	3681-71-8	142	7.93	1297	1.45 ± 0.07a	1.44 ± 0.07a	1.33 ± 0.17a	green, apple, grassy, banana
Geranyl acetate ester	105-87-3	196	13.36	1734	0.05 ± 0.01b	0.10 ± 0.00a	0.08 ± 0.01a	rose
Acetic acid, 2-phenylethyl ester	103-45-7	164	13.95	1787	3.60 ± 0.20ab	3.86 ± 0.07a	3.25 ± 0.36b	rose, honey, tobacco
Terpenes								
Linalool	78-70-6	154	10.91	1524	0.17 ± 0.01b	0.45 ± 0.02a	0.49 ± 0.03a	floral, citrus
α-Terpineol	98-55-5	154	12.67	1672	0.00 ± 0.00b	0.08 ± 0.01a	0.09 ± 0.01a	oil, anise, mint
Nerol (Cis-Gernaniol)	106-25-2	154	13.81	1774	0.01 ± 0.00c	0.06 ± 0.00a	0.05 ± 0.00b	rose, geranium, floral
β-damascenone	23726-93-4	190	14.05	1796	0.10 ± 0.01b	0.19 ± 0.02a	0.20 ± 0.01a	apple, rose, honey
Methyl Esters								
Octanoic acid, methyl ester (methyl octanoate)	111-11-5	158	8.94	1372	0.10 ± 0.02b	0.16 ± 0.02ab	0.17 ± 0.04a	orange
Decanoic acid, methyl ester (methyl decanoate)	110-42-9	186	11.56	1578	0.76 ± 0.09b	1.47 ± 0.23a	1.33 ± 0.38ab	wine
Ethyl Esters								
Hexanoic acid, ethyl ester (ethyl hexanoate)	123-66-0	144	6.92	1226	3.67 ± 0.26a	3.05± 0.10b	2.74 ± 0.26b	apple peel, fruit
Octanoic acid, ethyl ester (ethyl octanoate)	106-32-1	172	9.66	1426	4.14 ± 0.03a	3.21 ± 0.15b	2.88 ± 0.29b	fruit, fat
Decanoic acid, ethyl ester (ethyl decanoate)	110-38-3	200	12.15	1627	6.00 ± 0.96a	6.49 ± 0.78a	6.09 ± 1.00a	grape
Dodecanoic acid, ethyl ester (ethyl laurate)	106-33-2	228	14.41	1829	0.56 ± 0.07a	0.65 ± 0.05a	0.63 ± 0.10a	leaf
Esters								
Acetic acid, hexyl ester (hexyl acetate)	142-92-7	144	7.40	1260	1.45 ± 0.07a	1.44 ± 0.07a	1.33 ± 0.17a	fruit, herb
Volatile Fatty Acids								
Butanoic acid	107-92-6	88	11.73	1592	0.08 ± 0.01a	0.08 ± 0.00a	0.08 ± 0.00a	rancid, cheese, sweat
Hexanoic acid	142-62-1	116	14.20	1809	2.23 ± 0.06a	2.18 ± 0.07a	2.12 ± 0.07a	sweat
Alcohols								
1-Propanol, 2-methyl- (isobutanol)	78-83-1	74	4.90	1082	0.19 ± 0.02a	0.20 ± 0.01a	0.19 ± 0.01a	wine, solvent, bitter

1-Butanol, 2-methyl-, (S)-(2-methyl-1-butanol)	1565-80-6	88	6.43	1191	0.95 ±0.06 a	0.94 ± 0.03a	0.82 ± 0.04b	malt
1-Hexanol	111-27-3	102	8.41	1332	0.17 ± 0.01a	0.20 ± 0.01a	0.19 ± 0.01a	resin, flower, green
1-Octanol	111-87-5	130	11.04	1535	0.11 ± 0.01b	0.18 ± 0.01a	0.18 ± 0.01a	chemical, metal, burnt
2,3-Butanediol, [R-(R*,R*)]-(2,3-butanediol)	513-85-9	90	10.73	1510	0.38 ± 0.10a	0.31 ± 0.13a	0.53 ± 0.08a	fruit, creamy, onion
Phenylethyl Alcohol	60-12-8	122	14.91	1876	3.83 ± 0.60a	4.61 ± 0.20a	4.11 ± 0.23a	honey, spice, rose, lilac
Aldehyde								
Benzaldehyde, 4-methyl-	104-87-0	120	12.00	1615	0.18 ± 0.04a	0.21 ± 0.03a	0.18 ± 0.11a	fruity, cherry, phenolic, spice
Sulfide								
Methyldihydrothi-ophenone	13679-85-1	116	10.57	1497	0.10 ± 0.03a	0.20 ± 0.01b	0.12 ± 0.01a	cabbage, onion, must
Concentrations in relative abundance of internal standards mg/L DB-Wax column								

The result of wine aroma profiling by HS-SPME-GC/MS for 2018 Cayuga wine are found in **Table** 7. Significant differences were observed with increase in mono-terpene concentrations in CR-R and CR-S wines compared to C wine. Additional differences were observed in certain higher alcohols and esters with some being higher in C wine relative to CR-R and CR-S wines and others being higher in CR-R and CR-S wines compared to C wines.

Table 8: Wine aroma profiling by HS-SPME/GCMS color observed from 2018 Traminette wine for control (C), rapid cryogenic maceration using liquid nitrogen (CR-R), and slow cryogenic maceration (CR-S). Mean values are shown ± 1 SD of the mean, and results in the same row with different letters (a, b, c) are significantly different ($p < 0.05$).

2018 Traminette Wine Aroma Profiling HS-SPME-GC/MS								
Acetate Esters	**CAS**	**Mass**	**RT** (min)	**RI** (experimental)	**C**	**CR-R**	**CR-S**	**Odor Description**
Isobutyl acetate	110-19-0	116	3.84	1005	0.16 ± 0.05a	0.18 ± 0.01a	0.22 ± .02a	fruity, banana, sweet
Acetic acid, hexyl ester	142-92-7	144	7.39	1259	1.16 ± 0.39a	1.4 ± 0.24a	1.35 ± 0.12a	fruit, herb
3-Hexen-1-ol, acetate, (Z)-	3681-71-8	142	7.92	1296	0.03 ± 0.01a	0.02 ± 0.00a	0.03 ± 0.00a	green, apple, grassy, banana
Citronellol acetate	150-84-5	198	12.33	1643	0.14 ± 0.04b	0.92 ± 0.03a	0.74 ± 0.20a	rose, dust
Geranyl acetate ester	105-87-3	196	13.37	1734	0.30 ± 0.05b	0.88 ± 0.11a	0.77 ± 0.12a	rose
Terpenes								

α-Myrcene	123-35-3	136	5.78	1145	0.01 ± 0.00b	0.04 ± 0.00a	0.03 ± 0.00a	balsamic, must, spice
Ocimene	27400-71-1	136	7.07	1236	0.01 ± 0.00b	0.05 ± 0.00a	0.05 ± 0.00a	herb
Linalool	78-70-6	154	10.91	1525	0.48 ± 0.03b	1.72 ± 0.18a	1.94 ± 0.18a	floral, citrus
α-Terpineol	98-55-5	154	12.67	1673	0.08 ± 0.01b	0.23 ± 0.03a	0.28 ± 0.04a	oil, anise, mint
cis-Geraniol (Nerol)	106-25-2	154	13.81	1774	0.03 ± 0.00b	0.34 ± 0.03a	0.36 ± 0.04a	rose, geranium, floral
Geraniol	106-24-1	154	14.31	1820	0.14 ± 0.03b	1.23 ± 0.03a	1.30 ± 0.12a	rose, geranium
β-damascenone	23726-93-4	190	14.06	1797	0.13 ± 0.01b	0.24 ± 0.03a	0.27 ± 0.04a	apple, rose, honey
Methyl Esters								
Hexanoic acid, methyl ester (methyl hexanoate)	106-70-7	130	6.11	1169	0.01 ± 0.00a	.02 ± 0.00a	0.02 ± 0.00a	fruit, fresh, sweet
Octanoic acid, methyl ester (methyl octanoate)	111-11-5	158	8.95	1372	0.1 ± 0.03c	0.35 ± .02b	0.48 ± .05a	orange
Decanoic acid, methyl ester (methyl decanoate)	110-42-9	186	11.57	1579	0.45 ± 0.09b	2.10 ± 0.16a	2.75 ± 0.41a	wine
Ethyl Esters								
Hexanoic acid, ethyl ester (ethyl hexanoate)	123-66-0	144	6.91	1225	3.16 ± 1.13a	2.71 ± .28a	2.95 ± .51a	apple peel, fruit
Decanoic acid, ethyl ester (ethyl decanoate)	110-38-3	200	12.17	1630	5.51 ± 1.04c	10.84 ± 0.99b	15.44 ± 2.73a	grape, apple, fruity
Acetic acid, 2-phenylethyl ester (2-phenylethyl acetate)	103-45-7	164	13.95	1787	4.35 ± 0.23a	4.15 ± 0.23a	4.78 ± 0.32a	rose, honey, tobacco
Dodecanoic acid, ethyl ester (ethyl laurate)	106-33-2	228	14.42	1830	1.01 ± 0.27b	1.09 ± 0.08ab	1.59 ± 0.28a	leaf
Esters								
Hotrienol	20053-88-7	152	11.63	1584	0.06 ± 0.01b	0.10 ± 0.01a	0.12 ± 0.01a	hyacinth
Acetic acid, 2-phenylethyl ester (2-phenylethyl acetate)	2306-91-4	242	14.64	1851	0.05 ± 0.02c	0.17 ± 0.02b	0.23 ± 0.02a	waxy, banana, green
Volatile Fatty Acids								

Butanoic acid	107-92-6	88	11.72	1591	0.09 ± 0.01a	0.09 ± 0.00a	0.09 ± 0.01a	rancid, cheese, sweat
Butanoic acid, 3-methyl- (isovaleric acid)	503-74-2	102	12.23	1635	0.14 ± 0.01b	0.19 ± 0.01a	0.17 ± 0.02ab	sweat, acid, rancid
Hexanoic acid	142-62-1	116	14.2	1810	1.97 ± 0.14a	2.39 ± 0.14a	2.33 ± 0.33a	sweat
Alcohols								
1-Octanol	111-87-5	130	11.04	1536	0.1 ± 0.02b	0.29 ± 0.05a	0.30 ± 0.01a	chemical, metal, burnt
Phenylethyl Alcohol	60-12-8	122	14.93	1878	8.08 ± 0.44b	10.43 ± 0.80a	9.40 ± 1.06ab	honey, spice, rose, lilac
Aldehyde								
Benzaldehyde, 4-methyl-	104-87-0	120	11.99	1614	0.05 ± 0.04a	0.09 ± 0.02a	0.11 ± 0.04a	fruity, cherry, phenolic, spice
Sulfide								
Methionol	505-10-2	106	12.8	1684	0.07 ± 0.01b	0.15 ± 0.02a	0.11 ± 0.01b	sweet, potato
Methyldihydrothiophenone	13679-85-1	116	10.57	1497	0.19 ± 0.05c	1.63 ± 0.16a	0.93 ± 0.28b	cabbage, onion, must
Concentrations in relative abundance of internal standards mg/L DB-Wax column								

The result of wine aroma profiling by HS-SPME-GC/MS for 2018 Traminette wine are found in **Table** 8. Significant differences were observed with increases in mono-terpene and ester concentrations in CR-R and CR-S wines compared to C wine. Additional differences were observed in certain higher alcohols and volatile fatty acids with some being higher in C wine relative to CR-R and CR-S wines and others being higher in CR-R and CR-S wines compared to C wines.

Objective 3: . **Compare cryogenic maceration (CR) with short duration cold soak (CS) with respect to final wine quality and stability.**

Background & Rationale: Previous anecdotal reports have suggested that short duration skin contact in Traminette has aided in the extraction and enhancement of beneficial aroma and flavor compounds while minimizing the excess extraction of bitter and astringent phenolic compounds which are undesirable in white wines. A traditional style winemaking in the Alsace region of France where one of Traminette's parent varieties Gewurztraminer (*Vitis vinifera*) is from uses the use of skin contact to aid in the enhance meant of perceived fruity and floral aromas that are typical varietal characteristics of this grape variety. Previous research has focused on extended skin contact in Traminette over extended duration ranging from 12 to 48 hours. Due to the natural abundance of monoterpenes present in Traminette berry skin, ripe grapes may not need additional skin contact time, however because of the shorter growing season, cooler climate, and unpredictability of the growing season in the Northeastern United States as has been observed in the 2018 and 2019 vintages, optimal ripeness is not always achievable and additional methods to liberate these monoterpenes while mitigating excessive extraction of unwanted bitter/astringent phenolic compounds is needed. Additionally there is limited research on the effects of cold soaking (CS) on final wine quality in Cayuga grapes. A short duration CS of 6 hours at 4°C was decided upon for both varieties, based on the anecdotal reports and lack of previous research in this area. It was hoped that the short duration and cold temperature would mitigate unwanted oxidation and the excess extraction of bitter and astringent phenolic compounds while enhancing aromatic and flavor compounds and improving taste and mouthfeel. Alternatively a new system was implemented using dry

ice for the CR treatment and conducting all crushing/de-stemming, macerations, pressing, settling, and transfer in food grade plastic bags equipped with interchangeable valves and gaskets to limit exposure to oxygen. Three winemaking procedures were applied to each grape variety for the 2019 vintage and triplicate fermentation replicates were performed as follows:

- Control (C) – whole cluster fruit was crushed and de-stemmed into food grade plastic bags, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite and the bags were sealed. Then must was immediately pressed using an 80 L pneumatic bladder press and juice was transferred to another plastic bag and cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.
- Cryogenic Maceration (CR) – whole cluster fruit was crushed and de-stemmed stemmed into food grade plastic bags, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite. 10 lbs. of dry ice was added into the grape must and reduced must temperature from 4°C to -10°C and a semi-solid state in < 15 minutes. The bag were then sealed and placed into the WPP walk-in freezer at -20°C overnight. Frozen grape must was then thawed at ambient temperature and pressed using a 80 L pneumatic bladder press and juice was transferred to another plastic bag and cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.
- Cold Soak (CS) – whole cluster fruit was crushed and de-stemmed into food grade plastic bags, 30 mg/L sulfur dioxide (SO_2) was added to must as potassium metabisulfite and the bags were sealed. Sealed bags were placed in the in WPP walk-in refrigerator at 4°C for 6 hours. After 6 hours the must was immediately pressed using an 80 L pneumatic bladder press and juice was transferred to another plastic bag and cold settled at 4°C for 24 hours. Fermentation took place in 4 L glass micro-fermenters in triplicate replicates with *Saccharomyces cerevisiae*, Anchor Vin113.

Post fermentation, wines were cold settled at 4°C for 48 hours and then racked off of gross lees and 30 mg/L SO_2 was added to each wine. Wines were then cold stabilized for 21 days at 4°C and subsequently racked and 20 mg/L SO_2 was added prior to bottling in 375 ml glass bottles sealed with aluminum (Stelvin Closure) screw top closures. Wines were then stored at 4°C. Juice samples were collected and analyzed from post-press fractions prior to fermentation. Wine samples were collected and analyzed post bottling and additional samples of juice and wine were frozen at -80°C for future analysis.

Results: Currently all 2019 wines are finished and in bottle. Additional samples were collected at the time of bottling and frozen at -80°C for future analysis. Conventional, total phenolics, antioxidative capacity, wine aroma profiling, iron speciation, and tannin analysis have been conducted and are in the process of being analyzed. a descriptive analysis sensory panel (DA) was conducted on the 2019 Cayuga and Traminette wines, the results of which are currently being analyzed in addition to the analysis of the individual phenolics (+)-catechin, (-)-epicatechin, and gallic acid.

Future Work: A descriptive analysis sensory panel (DA) was conducted on the 2019 Cayuga and Traminette wines, the results of which are currently being analyzed and tabulated. Additionally the analysis of the individual phenolics (+)-catechin, (-)-epicatechin, and gallic acid by HPLC-UV/vis has been conducted on the 2018 and 2019 juice and wine and is currently under analysis and quantification. Glutathione analysis method development for 2018 and 2019 juice and wine analysis is currently under way and samples will be analyzed for reduced glutathione (GSH) in the near future.

Report: cloneMOBplus | Rpt Desc: MOB with Detailed DA | Fiscal Yr: 2019/2020(Ctd)

Account: 04-004-90 UP 8AH50 | Proj Corr: R J ELIAS | Acct Beg Date: 04/01/2017
Account Name: PDA EFFECT OF MACERATION | | Acct End Date: 10/15/2018
Sponsor: PDA | Award Amount: $22,581.00 | Proj End Date: 10/15/2018
Grant: 63016488 | Amount Allocated: $22,581.00 | Preaward Date: 00/00/0000
Fringe Rates -- Sal: 37.85 Tech Svc: 37.85 Grad: 13.00 Post Doc: 23.52 Wage: 7.86 Student: 0.25 | F&A Rate: 0.00 Cost Share: 0.00

Line Description	Total Budget	Total Encm	Actual	Balance
INCOME				
Fees	0.00	0.00	0.00	0.00
Sales and Service	0.00	0.00	0.00	0.00
Other Income	45,162.00	0.00	36,438.66	8,723.34
TOTAL INCOME	45,162.00	0.00	36,438.66	8,723.34
EXPENSE				
SALARIES				
STANDING APPOINTME				
Executive	0.00	0.00	0.00	0.00
Administrator	0.00	0.00	0.00	0.00
Academic Admin	0.00	0.00	0.00	0.00
Academic	0.00	0.00	0.00	0.00
Staff Exempt	0.00	0.00	0.00	0.00
Staff Non-Exemp	0.00	0.00	0.00	0.00
Technical Servi	0.00	0.00	0.00	0.00
Reserve Salary	0.00	0.00	0.00	0.00
TOTAL STANDING APPT	0.00	0.00	0.00	0.00
Fixed Term Multi-Ye	0.00	0.00	0.00	0.00
Non-Standing Academ	0.00	0.00	14,173.00	-14,173.00
Hmc Non-Standing Ac	0.00	0.00	0.00	0.00
Graduate Assistants	0.00	0.00	9,810.00	-9,810.00
Non-Stndg Non-Acade	28,789.00	0.00	0.00	28,789.00
Hmc Non-Stndg Non-A	0.00	0.00	0.00	0.00
TOTAL SALARI	28,789.00	0.00	23,983.00	4,806.00
WAGES	0.00	0.00	11,696.00	-11,696.00
DEPARTMENTAL ALLOTMENT				
Budget Allocation	4,800.00	0.00	0.00	4,800.00
Supplies and Materi	0.00	0.00	-173.66	173.66
Communications	0.00	0.00	0.00	0.00
Travel/Group Mtgs	0.00	0.00	757.33	-757.33

Report: cloneMOBplus Rpt Desc: MOB with Detailed DA Fiscal Yr: 2019/2020(Ctd)

Account: 04-004-90 UP 8AH50 Proj Corr: R J ELIAS Acct Beg Date: 04/01/2017
Account Name: PDA EFFECT OF MACERATION Acct End Date: 10/15/2018
Sponsor: PDA Award Amount: $22,581.00 Proj End Date: 10/15/2018
Grant: 63016488 Amount Allocated: $22,581.00 Preaward Date: 00/00/0000
Fringe Rates -- Sal: 37.85 Tech Svc: 37.85 Grad: 13.00 Post Doc: 23.52 Wage: 7.86 Student: 0.25 F&A Rate: 0.00 Cost Share: 0.00

Line Description	Total Budget	Total Encm	Actual	Balance
Rental - Equip/Bldg	0.00	0.00	0.00	0.00
Repairs/Maintenance	0.00	0.00	0.00	0.00
Miscellaneous Fees	0.00	0.00	0.00	0.00
Honor/Consult/Prof	0.00	0.00	0.00	0.00
Fringe Benefits	11,573.00	0.00	8,205.89	3,367.11
Purch/Comp/Photo Se	0.00	0.00	0.00	0.00
Printing/Advertisin	0.00	0.00	0.00	0.00
Moving/Relocations	0.00	0.00	0.00	0.00
Memberships	0.00	0.00	0.00	0.00
Equipment/Software	0.00	0.00	0.00	0.00
Miscellaneous	0.00	0.00	693.49	-693.49
TOTAL DEPT ALLOTME	16,373.00	0.00	9,483.05	6,889.95
TOTAL EXPENSE	45,162.00	0.00	45,162.05	-0.05
NET INCOME/(EXPENSE)	0.00	0.00	-8,723.39	8,723.39