Fruit Ripening Profiles of Cold Climate Wine Grape Cultivars

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Background and Rationale:
The physical and chemical composition of wine grapes at harvest is a key factor that determines the fruit quality characteristics, and ultimately, the quality of the wine produced. As berries ripen, their chemical composition changes with regards to sugars, organic acids, phenolics, and other compounds. While these ripening profiles have been well characterized for *Vitis vinifera* cultivars, little is known about the changes of chemical composition in cold climate wine grape cultivars. Therefore, knowledge of the developmental profiles of these compounds is important for determining optimal harvest times to make quality wines.

Experimental Design:
We tracked the common field indicators used by viticulturists and winemakers to predict grape maturity throughout the growing season. Along with the field indicators, we performed chemical analyses of sugars and organic acids to describe seasonal concentration changes for the predominant sugars and acids found in grape juice.

Methods:
Berry sampling was carried out on 11 wine grape cultivars, which included seven cold climate and four *V. vinifera* cultivars. Four replicates of 10 berries per cultivar were sampled approximately every 10 days from August to October during the growing seasons of years 2010, 2011, 2012, and 2013. Harvest dates were converted to Growing Degree Days (GDD) (°C) accumulated since April 1 of the year, using 10 °C as the base temperature.

Cold climate wine grape cultivars	*V. vinifera* cultivars
Frontenac	Chardonnay
Frontenac gris	
Marquette	Merlot
La Crescent	
St. Croix	Pinot Noir
St. Pepin	Riesling
Marechal Foch	

Berries were juiced with a hand juicer. Grape juice was measured for soluble solids (expressed in °Brix), titratable acidity (TA), and pH using a refractometer, a titrator, and a pH meter, respectively. Profiles for sugar and organic acids were measured separately by liquid chromatography-mass spectrometry (LC-MS) using a Waters BEH Amide column (2.1 × 100 mm, 1.7 µm).

Results:

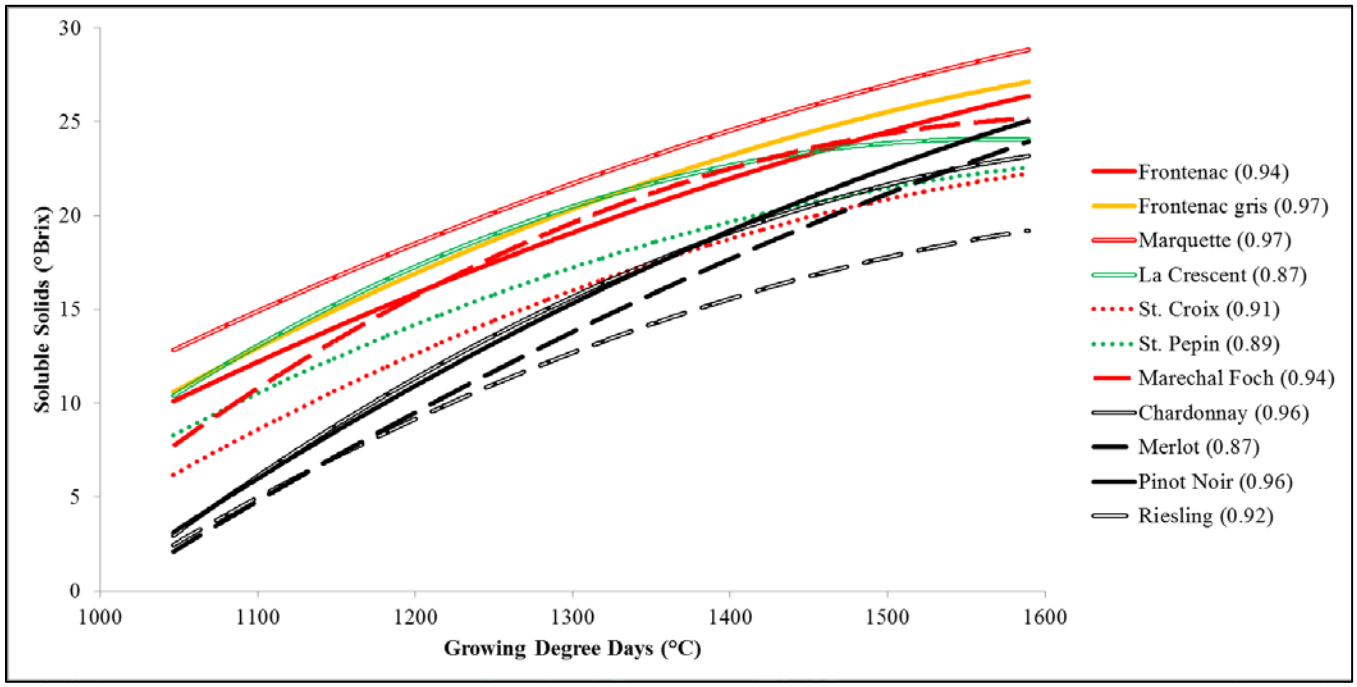

Figure 1: Change in soluble solids content (expressed in °Brix) over the berry ripening season for seven cold climate wine grape cultivars and four *V. vinifera* cultivars based on harvests from year 2010 to 2013 in Minnesota. Shown in parentheses are the coefficient values of data fitted by linear regression.

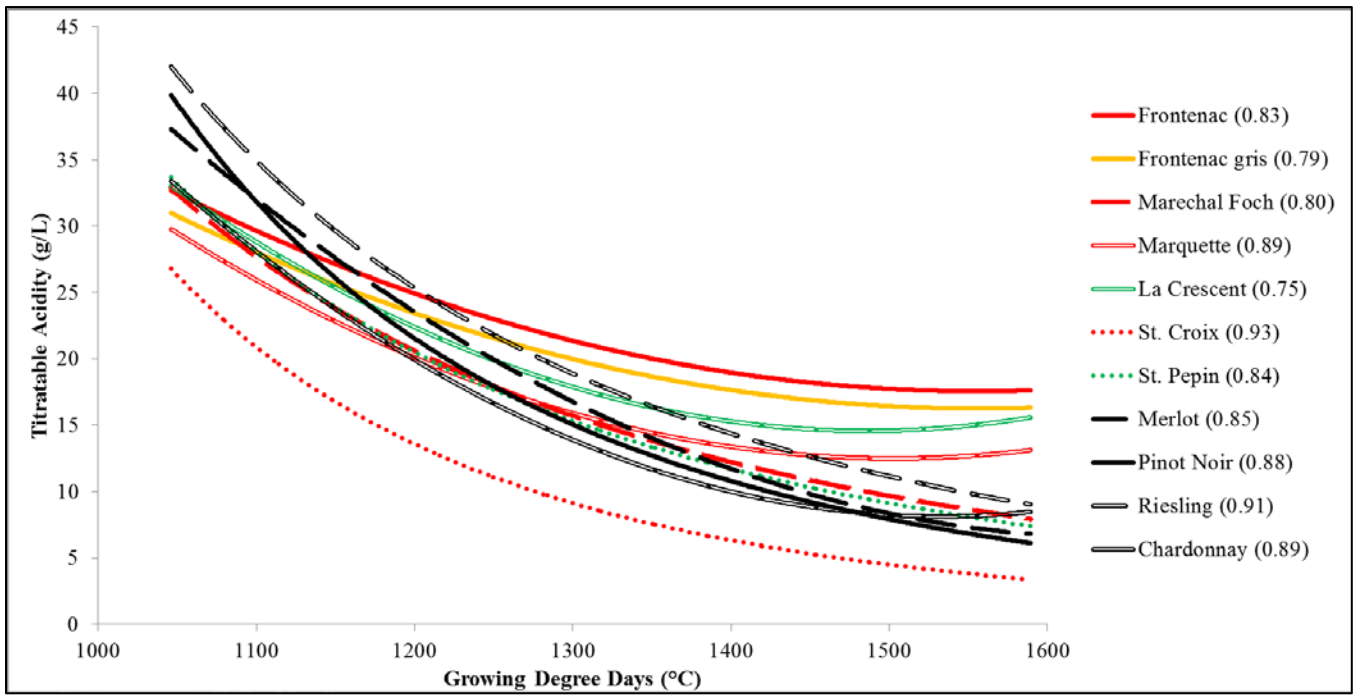

Figure 2: Comparisons of variations in titratable acidity between seven cold climate wine grape cultivars and four *V. vinifera* cultivars over the berry ripening season from year 2010 to 2013 in Minnesota. Shown in parentheses are the coefficient values of data fitted by power regression.

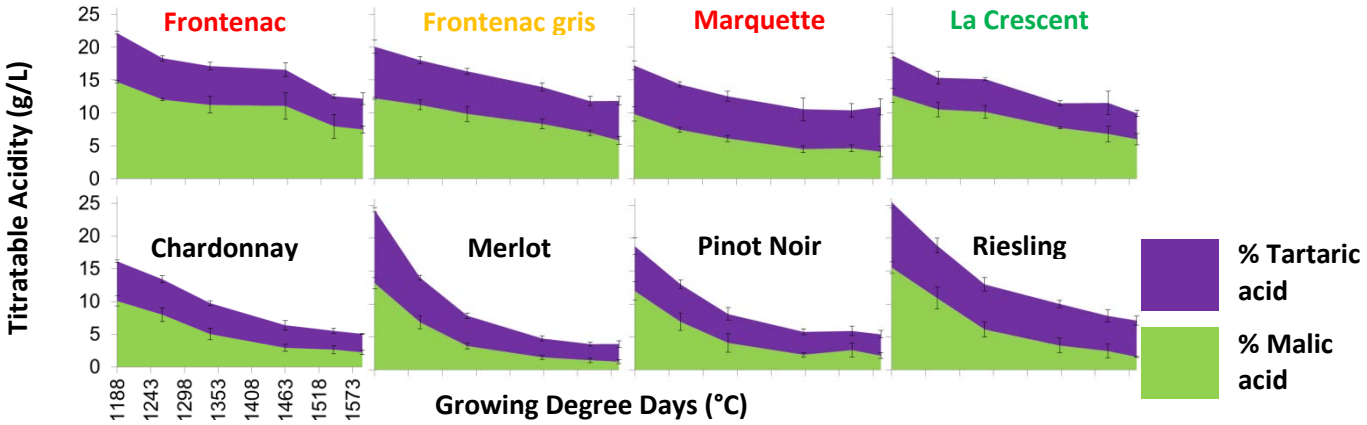

Figure 3: Variation in tartaric and malic acid proportions for four cold climate wine grape cultivars and four *V. vinifera* cultivars at six sampling dates during the berry ripening season in 2012.

What the results mean:

- Accumulated GDD was a reliable predictor of grape ripening in Minnesota explaining from 87 to 97% of the seasonal of the variation in soluble solids content and 75 to 91% of the variation in titratable acidity depending on the cultivar.
- Based on the patterns of chemical composition change recorded from year 2010 to 2012, the cold climate cultivars generally started with a higher soluble solids content than the *V. vinifera* cultivars at the onset of ripening, but as the growing season progressed, they exhibited a more gradual accumulation of soluble solids.
- Meanwhile for titratable acidity, the cold climate cultivars began with a lower concentration of acidity, and the concentration continued to decline gradually toward harvest time, which was in contrast to the steep decline seen in the *V. vinifera* cultivars.
- Cold climate cultivars retained higher concentrations of organic acids throughout the ripening period, compared to *V. vinifera* cultivars.
- Throughout the ripening period in 2012, the proportion of tartaric to malic acid was relatively constant in Frontenac, Frontenac gris, and La Crescent. In contrast, Marquette and the four *V. vinifera* cultivars exhibited an increasing ratio of tartaric to malic acid as berries ripened.
- Analysis of the ripening profiles for soluble solids content revealed a relatively constant ratio of glucose to fructose (1:1) throughout the ripening stage in both cold climate and *V. vinifera* cultivars.