Final Report to the New York Wine and Grape Foundation

Project funded in 2020-21

STUDIES PERTAINING TO ENOLOGY; WINE AND HEALTH; AND GRAPE JUICE AND HEALTH STUDIES

Title: Expanding opportunities for canned wines - developing and validating models for predicting for corrosion and off-aroma formation

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Date of report: Feb 3, 2021

Executive Summary: The value of wines packaged in aluminum cans has grown by almost 100-fold in the last decade, but producers report that canned wines (and related products like ciders) often have shorter shelf life than conventionally packaged wines. Specifically, canned wines may undergo corrosion and develop ‘reduced’ aromas due to formation of H_2S (“rotten egg” aroma) from reaction of sulfur dioxide (SO_2, also referred to as “sulfites”) with aluminum. Aluminum beverage cans contain protective polymer liners, but SO_2 appears able to circumvent this barrier, especially in newer BPA – Non-intent (BPA-NI) liners being adopted by industry. Beverage can manufacturers offer pre-canning evaluations and recommendations for limits on SO_2; they also provide recommended limits for wine components suspected of accelerating this corrosion process, such as copper and chloride. However, these recommendations are largely unvalidated. The overall objective of this proposal was to develop and validate accelerated aging tests for H_2S formation in canned wines and use these tests to determine how wine composition affects compatibility with can storage.

Although the project start was delayed by several months due to the COVID19 pandemic, we successfully developed an accelerated aging assay for canned wines. Preliminary work indicates that red wines are of low risk for H_2S formation even if they have high free SO_2. Newer liners based on acrylic have the highest risk of H_2S formation, with lower risk for both epoxy and epoxy-acrylic.

Project Objectives:

1) Using commercial and model wines, develop and validate accelerated aging tests that predict corrosion and H_2S formation during long-term storage.

2) Develop and validate multivariate models to relate wine composition to the rates of corrosion and H_2S formation in canned wines with varying liner types.

Progress towards Objectives (Methods, Results, Analysis)

Despite a 3 month delay to project initiation due to COVID19 mandated lab shutdown, we have made significant progress on our objectives.

Objective 1: develop and validate accelerate aging tests

We have developed a novel protocol for accelerated aging tests of beverage × can compatibility. Aluminum coupons (1 x 2 cm) were coated with one of three commercial liners (epoxy, epoxy acrylate, and acrylate). The exposed edges were covered with an impermeable hot melt glue. The coupon was placed in a 20 mL glass crimp-top vial, and the vial filled with either a model or commercial wine. By purging the vials with inert gas prior to sealing with crimped butyl rubber septa, we could achieve undetectable levels of total package oxygen and dissolved oxygen pickup (<10 ppb) after 1 week storage time at elevated temperatures. (Fig 1)

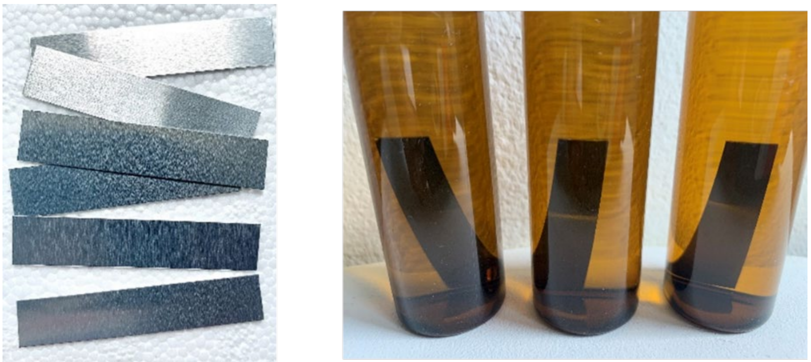

Figure 1 - (left) Aluminum coupons coated with common can coating materials; (right) coated coupon immersed in white wines for accelerated aging trials

For accelerated aging trials, vials were held at 3 days at 50 °C, and H_2S was measured using gas detection tubes. This time-temperature combination was selected because it allowed for measurable H_2S to be formed even with the least permeable coating (epoxy). The test was also sufficiently reproducible, with relative standard deviations (RSD) ~20%.

Initial results for the accelerated aging test were logical. We observed higher H_2S production for white wines than red wines. We also observed the highest production of H_2S with acrylic coatings, and the lowest production with epoxy coatings. Representative data is shown in Figure 2. These results align with anecdotal reports from winemakers

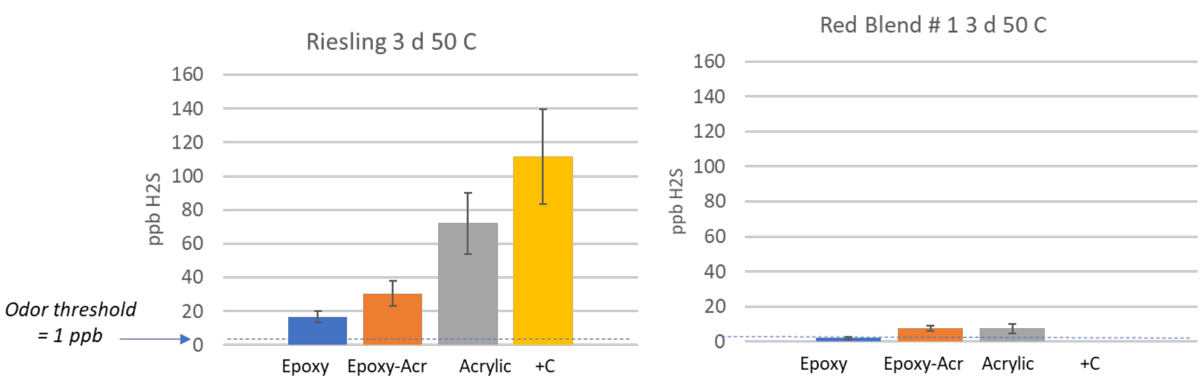

Figure 2 – H_2S production during accelerated aging tests of aluminum coupons stored in either Riesling (left) or a Red Blend (right), both sourced from the Finger Lakes. Coupons varied in liner composition: Epoxy, Epoxy-Acrylate, or Acrylic. A control (+C, uncoated coupon) was also included. The sensory threshold for H_2S in wine is ~1 ppb.

We are currently in the process of <u>validating</u> the new accelerated aging assay.

- A total of twelve wines have been packaged in aluminum beverage cans with one of three different can liners.
- Approximately half of the wines were sourced from NY State. Varietals include both red and whites (Chardonnay, Riesling, Sauvignon blanc, Cabernet franc, Merlot) and their blends.
- Wines will be sampled at multiple intervals (1, 3, and 6 months) for analysis.
- Data will be compared against the same wines stored under accelerated aging conditions.

Objective 2: evaluate the effects of wine composition on H2S production using model wines

The start of Objective 2 was delayed due to the pandemic and the need to initially validate the accelerate aging test. We are commencing accelerated aging testing of model wines containing 30 mg/L free SO_2. The model wines will differ in components suspected to exacerbate H2S formation: pH, Ethanol, Copper, Chloride, Tartaric Acid, Polyphenols.

Table 1 – Fractional factorial design to be used for evaluating the effects of model wine composition on H_2S production. All wines will contain 30 mg/L free SO_2.

Model Wine	pH	EtOH (%v/v)	Cu (mg/L)	Cl- (mg/L)	Tartaric acid (g/L)	Polyphenols (g/L catechin)
1	2.8	16	0.05	600	10	0.1
2	2.8	7	2	50	10	0.1
3	2.8	16	0.05	600	2	2
4	2.8	16	2	50	10	2
5	2.8	7	0.05	50	2	2
6	2.8	7	2	600	2	0.1
7	4.2	7	2	600	2	2
8	4.2	16	2	50	2	0.1
9	4.2	7	0.05	50	10	2
10	4.2	16	0.05	50	2	0.1
11	4.2	16	2	600	10	2
12	4.2	7	0.05	600	10	0.1