Influence of packaging material on the properties of carbonated muscadine wine under ambient storage conditions

Nicholas A. Wendrick; Andrew J. MacIntosh, Ph.D.; and Katherine A. Thompson-Witrick, Ph.D.

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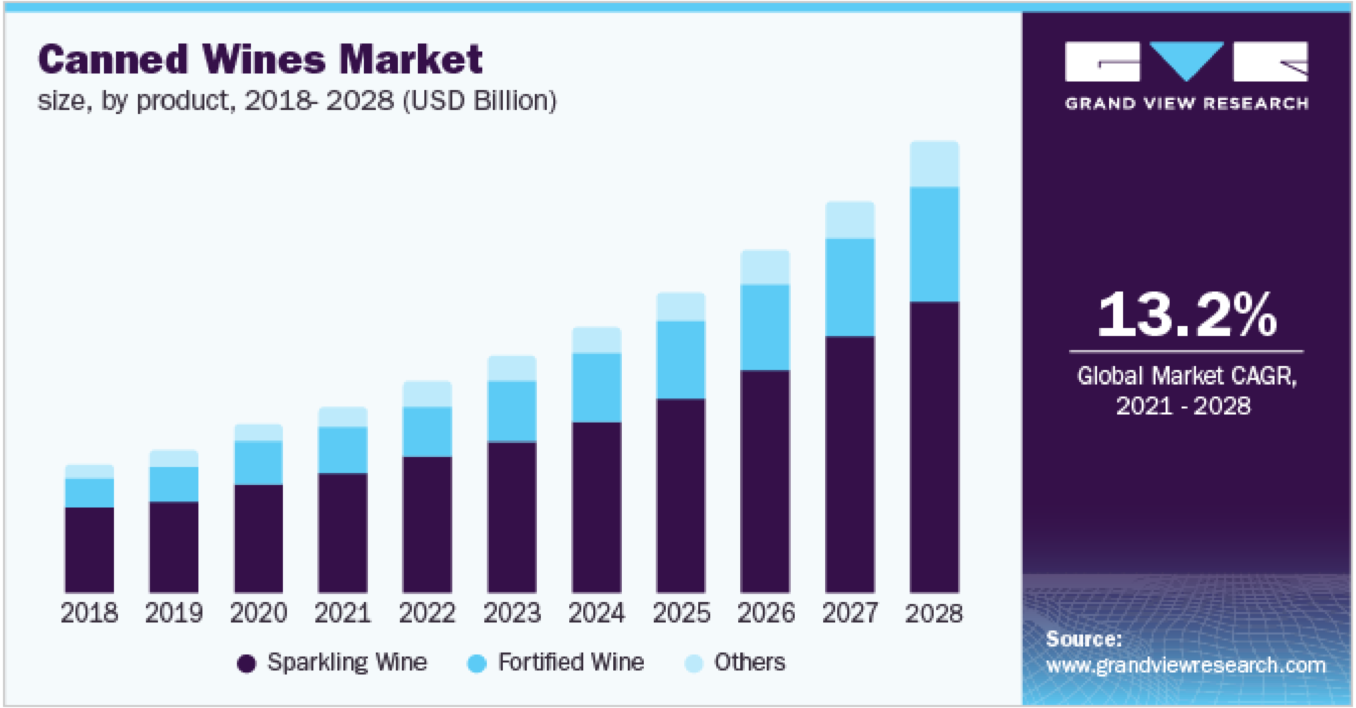
Introduction

- Canned wine has been gaining popularity for years
  - Single serving
  - Less breakage
  - Recyclability
- 2023: $554 million in sales
- CAGR: sees continual growth
  - 17.1% Future Market Insights
  - 13.1% Global Market Insights
  - 13.2% Grand View Research
- Sparkling wine: 8.8 billion (2024)



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Cans	
Pros	Cons
Resistant to oxidation, cork taint, and breakage	Low internal strength, pressurization necessary
Lighter, cheaper, and more sustainable than glass	Suspectable to flavor scalping, flavor tainting, and other negative chemical changes
Popular at venues where glass is prohibited	Negative consumer perception of canned wine
Can size lead to casual consumption	Capital equipment cost
Can art and creative labels	

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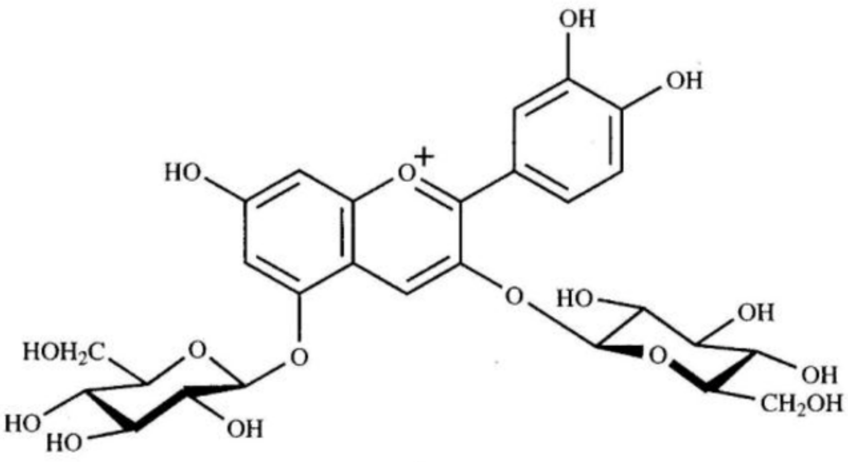
Packaging Influence on Color



Cyanidin 3,5-di-O-glucoside

Table 2
Six major anthocyanidin groups (MeO: methoxy group; OH: hydroxyl group; H: hydrogen) modified from Welch et al. (2008) [39].

Anthocyanidins	Substitutions						
	R_3	R_5	R_6	R_7	$R_{3'}$	$R_{4'}$	$R_{5'}$
Cyanidin (Cy)	OH	OH	H	OH	OH	OH	H
Delphinidin (Del)	OH	OH	H	OH	OH	OH	OH
Pelargonidin (Pg)	OH	OH	H	OH	H	OH	H
Peonidin (Pn) (from Cy)	OH	OH	H	OH	OMe	OH	H
Petunidin (Pt) (from Del)	OH	OH	H	OH	OMe	OH	OH
Malvidin (Mv) (from Del)	OH	OH	H	OH	OMe	OH	OMe

- Six main types of anthocyanidins in muscadine wine
  - Cyanidin, Delphinidin, Pelargonidin, Peonidin, petunidin, and Malvidin
- Degradation of muscadine wine primarily due to type of anthocyanin present
- Poor stability of the 3,5-O-diglucoside compared to 3-monoglucoside in Vitis vinifera

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Objective

- Determine the influence packaging type has on the physiochemical characteristics of carbonated muscadine wine at ambient temperature over a six-month shelf-life study.

Methods

- Red noble muscadine wine donated from Paulk Vineyards
- Wine was carbonated to 3 vol/vol
- Packaged in glass bottles and cans
    - 187 mL champagne style bottles with natural cork and cap
    - 355 mL aluminum cans
- Stored at ambient temperature (~25 ºC)

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Sampling

- Temperature and humidity monitored
- Samples pulled every 15 days over 180-day time frame
    - 0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 160, 175 and 180 .
- Packages degassed for 2 minutes via sonication
- Stored at -20 C until analyzed

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Analysis

Physiochemistry

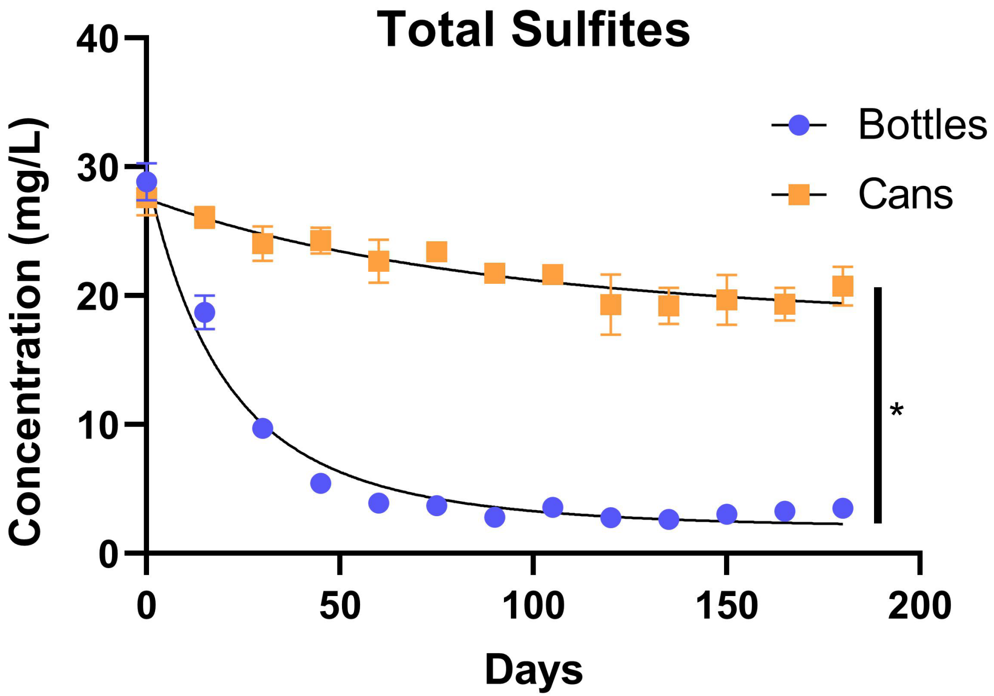
- ABV, Total soluble solids (TSS), Density (Anton-Parr)
- **Free and total Sulfites (Ripper method)**
- Color (Glories method)
- pH and TA (AOAC methods)

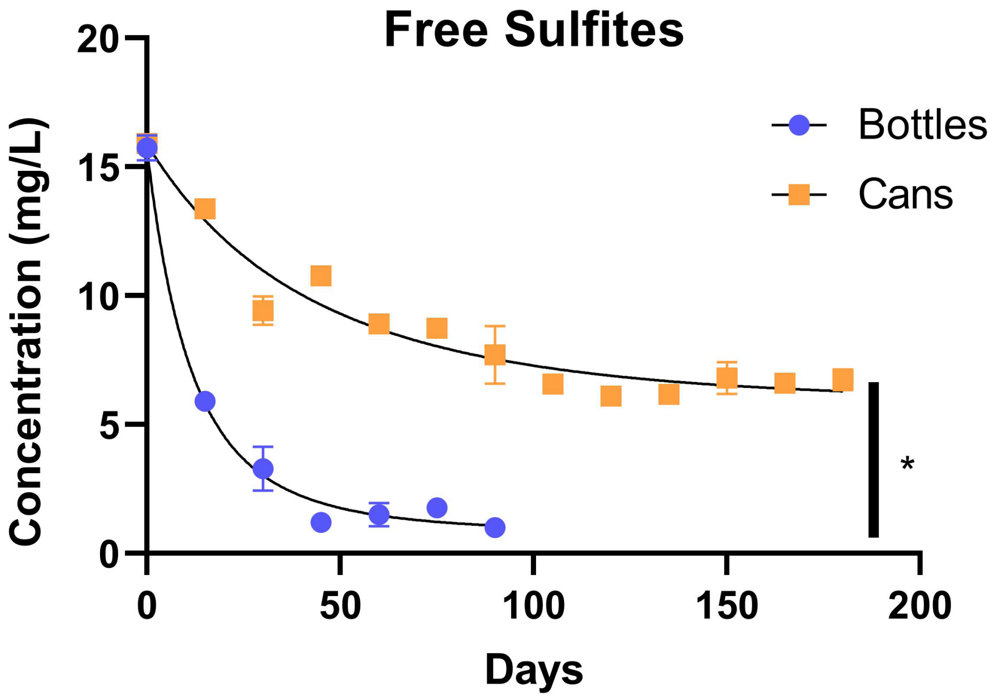
Analytical Chemistry

- **GC-MS – volatile and semi-volatile compounds**
- **Anthocyanins (HPLC)**
- **FTIR (Packaging)**
- **Statistics – One-way ANOVA and Tukey's HSD**

*Bold indicates areas of focused for presentation

Sulfites





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Analysis of Volatile and Semi-Volatile compounds

- Shimadzu QP-2010 Plus coupled with QP2010 SE MSD
- Extraction: SPME fiber (DVB/CARB/PDMS)
  - Salt (30% w/v)
  - Extraction
    - Sample size: 10 mL in 20 mL HS vial
    - 30 mins @ 40°C
    - Agitated 250 rpm
- Identification Compounds
  - Standards
  - Nist library
  - LRI

Thompson-Witrick et al. 2015

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Volatile Composition

	Beginning (mg/L)		End (mg/L)	
	Bottles	Cans	Bottles	Cans
Acids	0.45 ± 0.25	0.37 ± 0.15	0.09 ± 0.09	0.12 ± 0.10
Alcohols	14.00 ± 5.01	18.11 ± 1.86	24.84 ± 4.20	22.34 ± 5.42
Aldehydes	0.04 ± 0.03	0.01 ± 0.01	0.02 ± 0.01	0.07 ± 0.03*
Esters	4.77 ± 1.83	5.03 ± 0.57	3.18 ± 0.30	4.18 ± 1.24
Terpenes	0.04 ± 0.01	0.06 ± 0.01*	0.03 ± 0.01	0.07 ± 0.04
Total	19.31 ± 6.73	23.57 ± 2.31	28.17 ± 4.03	26.79 ± 6.24

VOCs were compared between bottles and cans at the beginning (Day 0 and Day 15) and end (Day 165 and 180).
Mean ± SD; n = 6. *Represents statistical significance.

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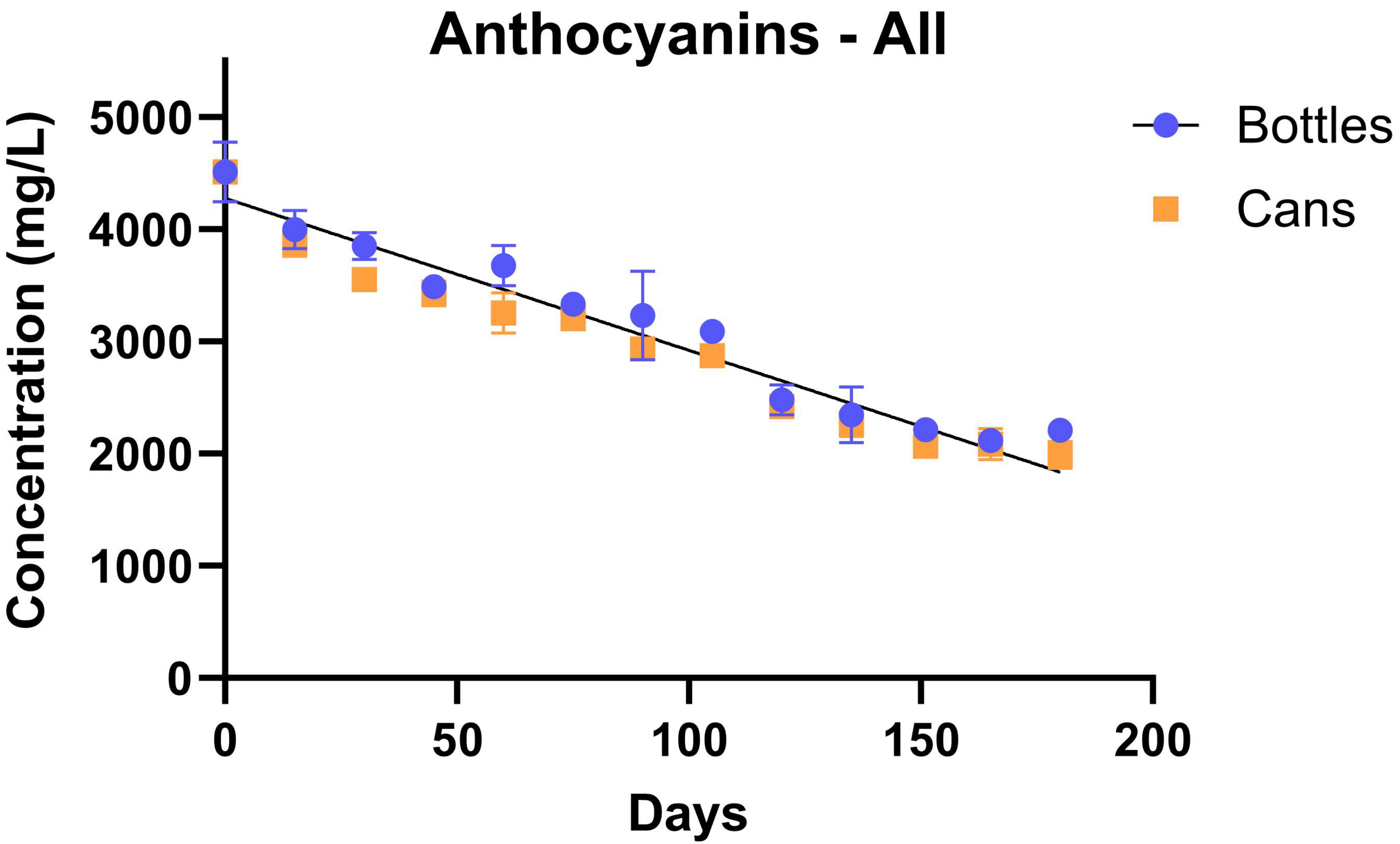
Anthocyanins

- HPLC with automatic sampler
- Diodade Array Detector (DAD) - 520 nm
- C18 column
- Identification and Quantification using a five-point curve:
  - Cyanidin
  - Delphinidin
  - Pelargonidin
  - Peonidin
  - Petunidin
  - Malvidin

Sandhu, A. K., & Gu, L. (2010).

Total Anthocyanins



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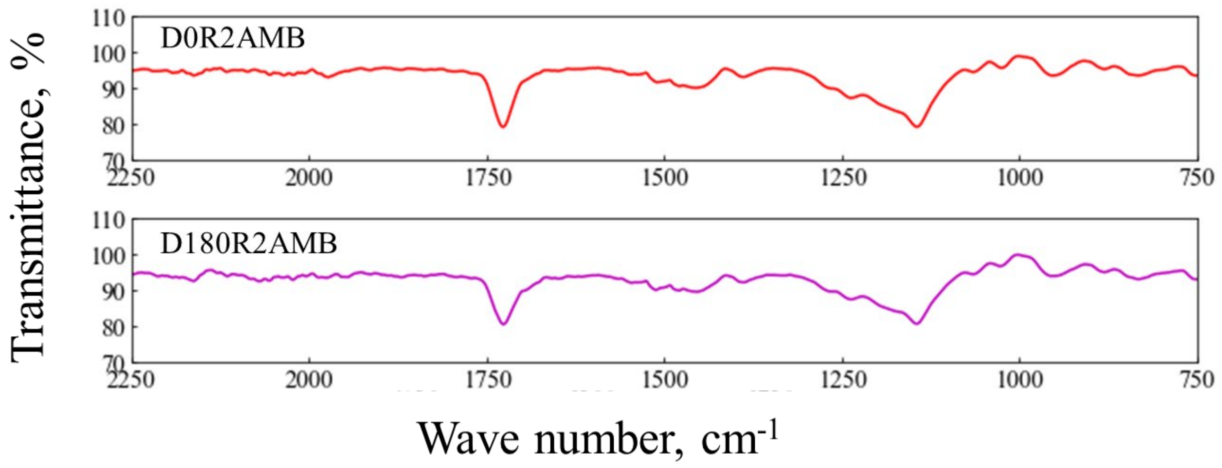
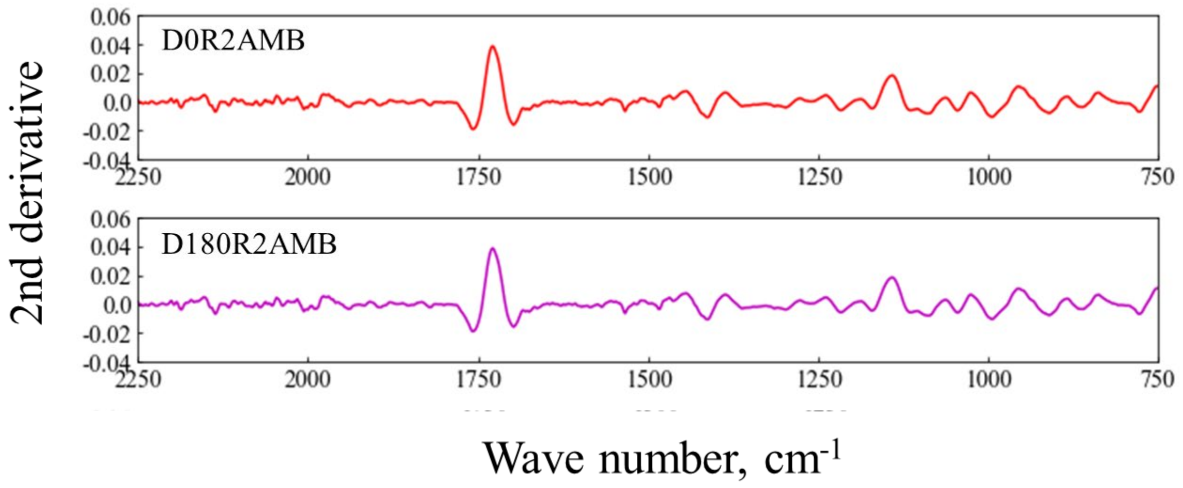
Packaging Analysis - FTIR





Conclusions

- Total sulfites changed during ambient (free sulfites) study
- Aroma and flavor compounds were statistically significant for some classes but not substantially different in concentration across all VOCs
- Remaining physicochemical analyses (pH, TA, alcohol, sugar, etc.) and all five-anthocyanin concentrations did not significantly change over time between bottles and cans for both experiments
- Suggesting aluminum cans may be a viable packaging alternative for carbonated muscadine wine

Acknowledgments

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Questions

References

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2. Sandhu, A. K., & Gu, L. (2010). Antioxidant capacity, phenolic content, and profiling of phenolic compounds in the seeds, skin, and pulp of Vitis rotundifolia (muscadine grapes) as determined by HPLC-Dad-ESI-MSn. Journal of Agricultural and Food Chemistry, 58(8), 4681–4692. https://doi.org/10.1021/jf904211

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Appendix - Physiochemical

	pH	TA (g*/L)	Ethanol (%v/v)	Brix (°)	RS (g/L)
Bottles	3.15 ± 0.02	6.26 ± 0.53	11.97 ± 0.08	2.78 ± 0.21	69.18 ± 2.25
Cans	3.14 ± 0.04	6.22 ± 0.39	11.78 ± 0.22	2.67 ± 0.14	67.45 ± 2.12

Cumulative values across experiment due to no significance between bottles and cans. *grams of tartaric acid