WEBINAR

Exploring the Impact of Oxygen Transmission Rates and Ascorbic Acid on Cannabinoid-Infused Beverage Stability

Derek J. Averill, Ph.D.
Director of Chemistry
Cannabis Testing Services
SMITHERS

Kristofer Marsh, Ph.D.
Chief Scientific Officer
NY State Director
Cannabis Testing Services
SMITHERS

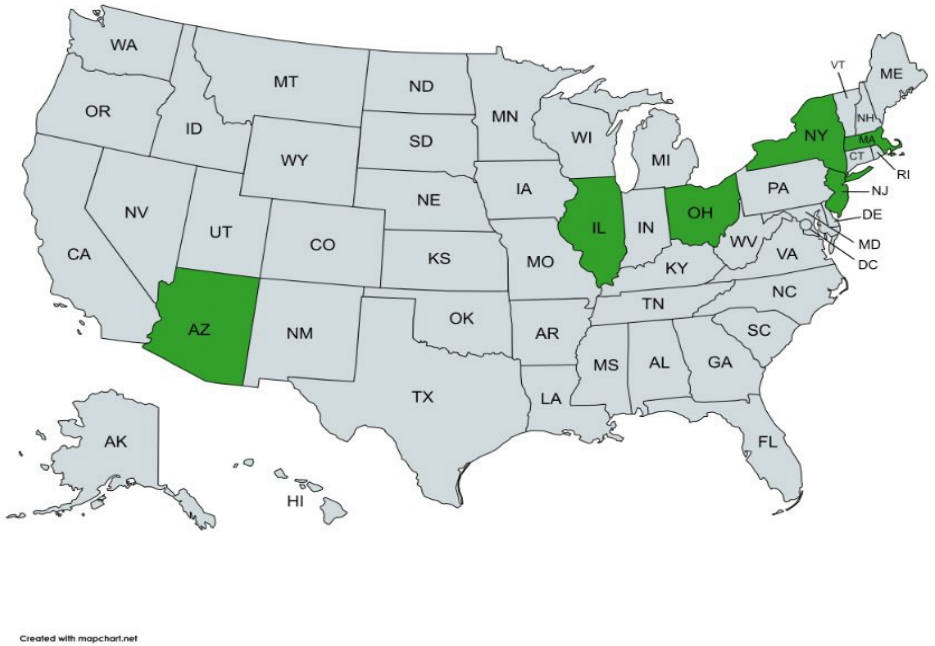
Harold Han, Ph.D.
Chief Scientific Officer
VERTOSA

About Smithers

- **Smithers Cannabis Testing Services**
  - AZ, IL, MA, NJ, NY, and OH
  - Fully licensed

- We provide technical expertise to help the cannabis industry **grow and innovate with confidence**

- 2025 is Smithers' **100th anniversary**



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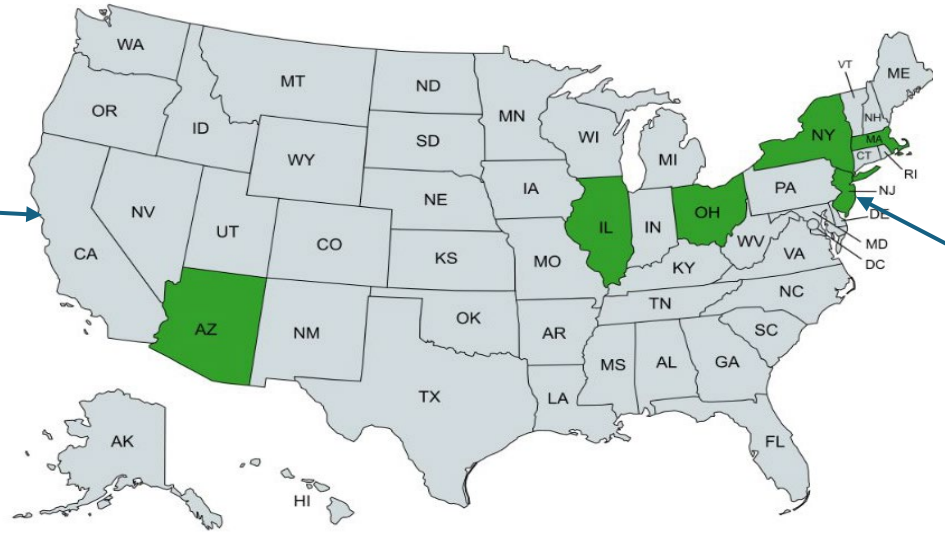
Project Team

Camron Clifton
Vertosa
Technical Services Manager



Braden Wachtmann-Smoot
Smithers
Lab Manager, New Jersey

Bailey Carden
Smithers
Associate Chemist

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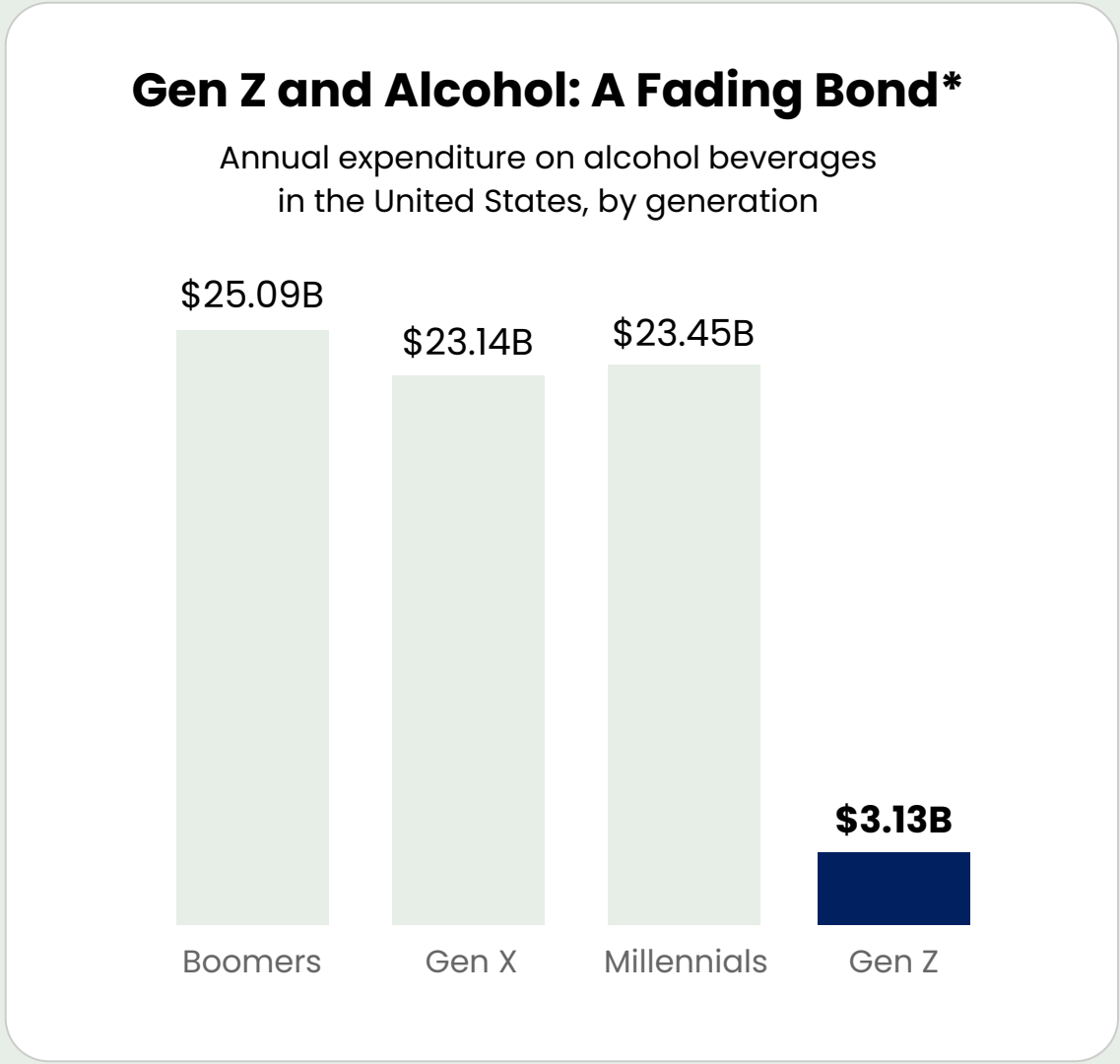
Alcohol consumption is dramatically declining, especially among Gen Z

*U.S. Bureau of Labor Statistics, 2024



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Cannabis beverage entered the mainstream market and consumers love it!

Table 1: Minnesota Hemp D9 Beverage Potency Results						
				Tested Potency at Anresco		
Brand	SKU	Manufacture Date to Testing Date (month)	Target potency (THC)	Tested potency	Discrepancy	
Brand 1	SKU 1.1	2	5 mg	3.96 mg	-1.04 mg	-20.8%
Brand 2	SKU 2.1	<1	5 mg	4.34 mg	-0.66 mg	-13.2%
Brand 3	SKU 3.1	3	50 mg	50.94 mg	0.94 mg	1.8%
	SKU 3.2	3	50 mg	49.8 mg	-0.2 mg	-0.4%
Brand 4	SKU 4.1	5	5 mg	6.77 mg	1.77 mg	32.9%
	SKU 4.2	4	5 mg	4.73 mg	-0.27 mg	-7.1%
Brand 5	SKU 5.1	11	5 mg	<LOQ	-5 mg	-100.0%
Brand 6	SKU 6.1	n/a	5 mg	5.88 mg	0.88 mg	17.6
Brand 7	SKU 7.1	4	12 mg	10.88 mg	-1.12 mg	-9.3%
Brand 8	SKU 8.1	n/a	2.5 mg	2.56 mg	0.06 mg	2.4%
Brand 9	SKU 9.1	3	5 mg	3.82 mg	-1.18 mg	-23.6%
Brand 10	SKU 10.1	5	3 mg	2.77 mg	-0.23 mg	-7.7%
Brand 11	SKU 11.1	6	2 mg	<LOQ	-2 mg	-100.0%
Brand 12	SKU 12.1	4	5 mg	5.47 mg	0.47 mg	9.4%
Brand 13	SKU 13.1	5	2 mg	2.78 mg	0.78 mg	39.0%
Brand 14	SKU 14.1	1	3 mg	3.39	0.39 mg	13.0%

Fast growth can lead to neglect of quality, which is reflected in potency stability

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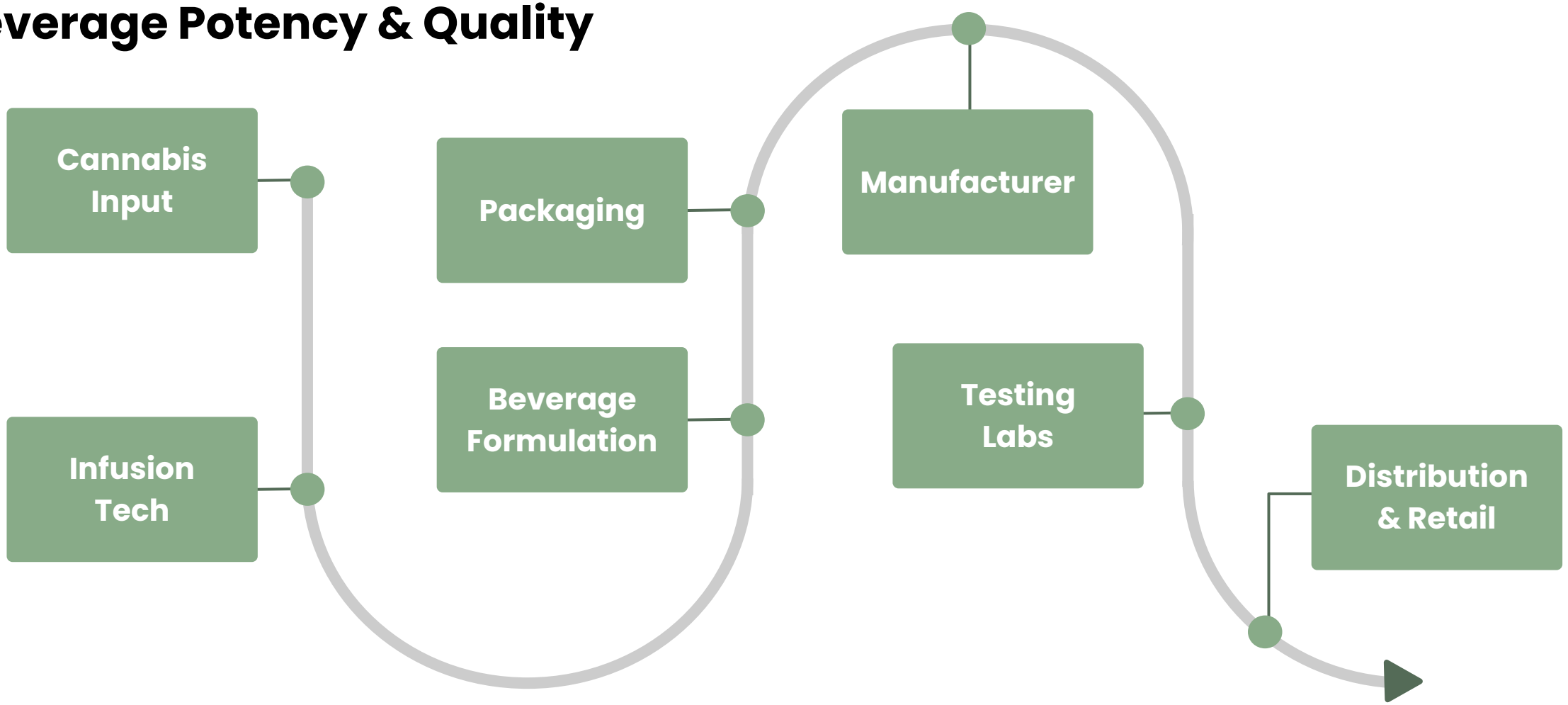
7 Key Steps Impacting Cannabis Beverage Potency & Quality



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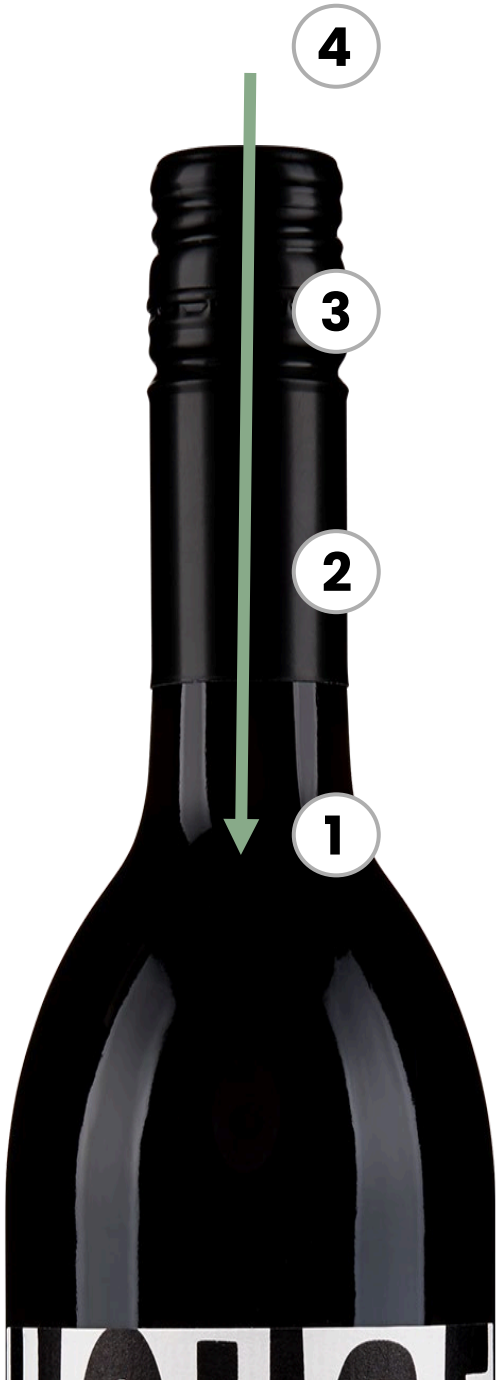

The relationship between Oxygen <> Packaging <> Liquid

1. Dissolved O_2
2. O_2 in the headspace
3. O_2 within the closure

\+ 4. O_2 permeability through the closure

Total O_2

Source:
Wine Business Weekly

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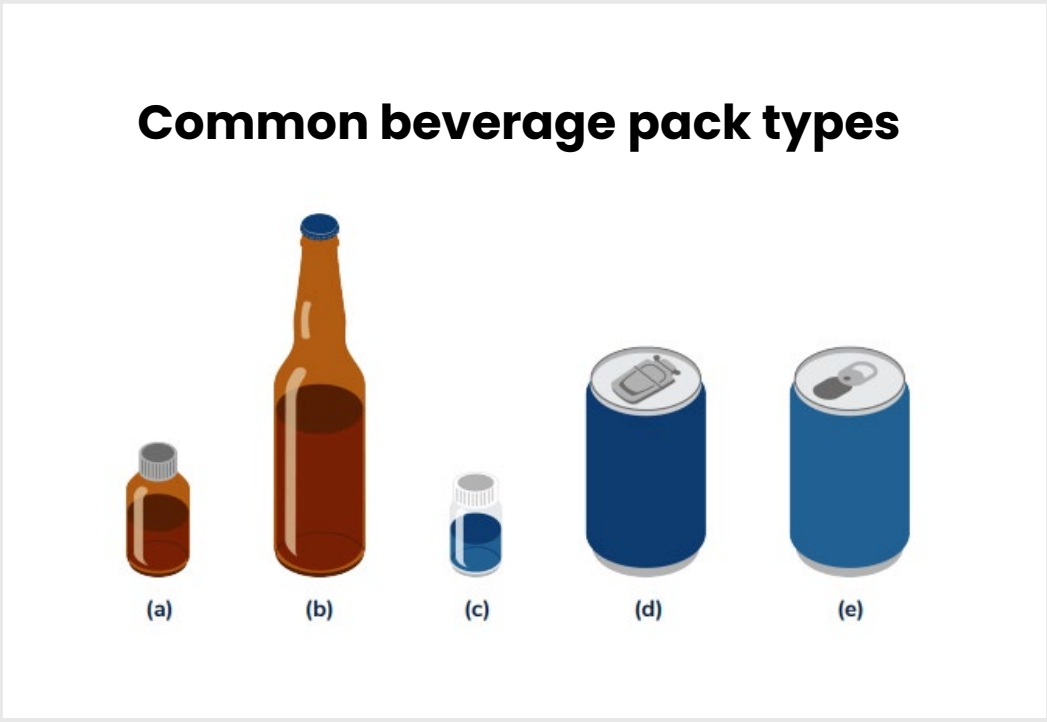
Measuring Oxygen Transmission Rate



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Measuring Oxygen Transmission Rate

- OTR determined in accordance with ASTM F1307-20
- The sample was mounted such that the inside was purged with a carrier gas while the outside was exposed to air (20.9% oxygen) at **23°C, 50%rh**
- Samples were tested until equilibrium was achieved
- Two replicates per sample were tested (10 replicates total)
- Results are quoted for 100% oxygen

ASTM F1307-20 ⓘ

Standard Test Method for Oxygen Transmission Rate Through Dry Packages Using a Coulometric Sensor

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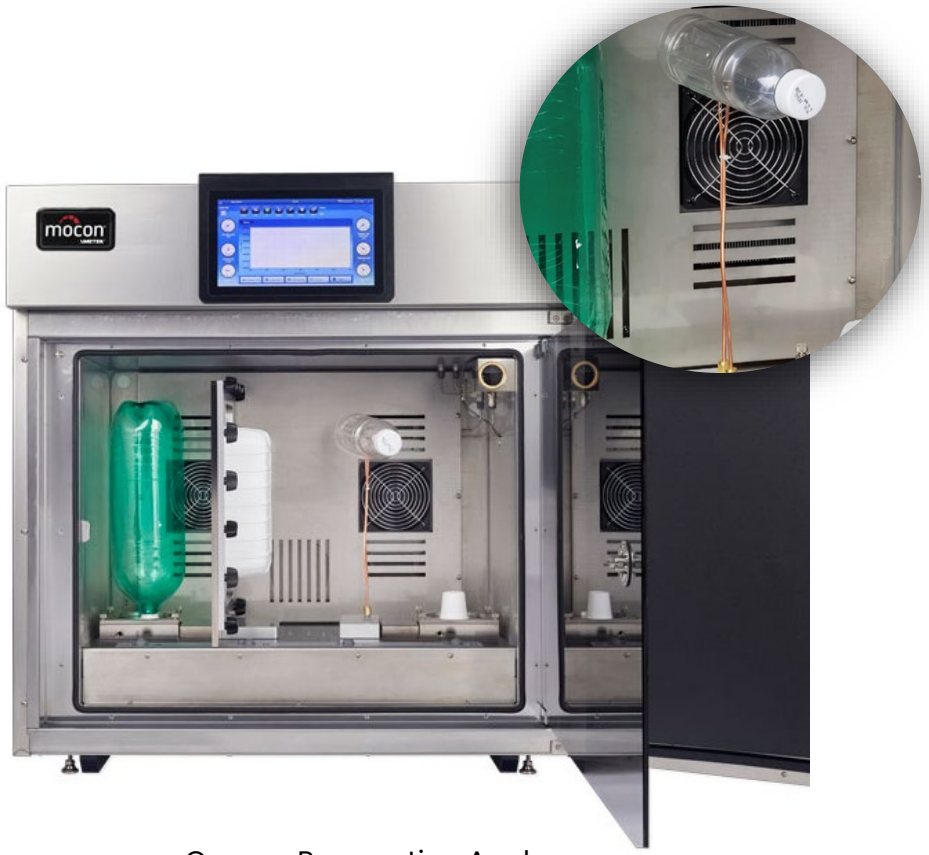
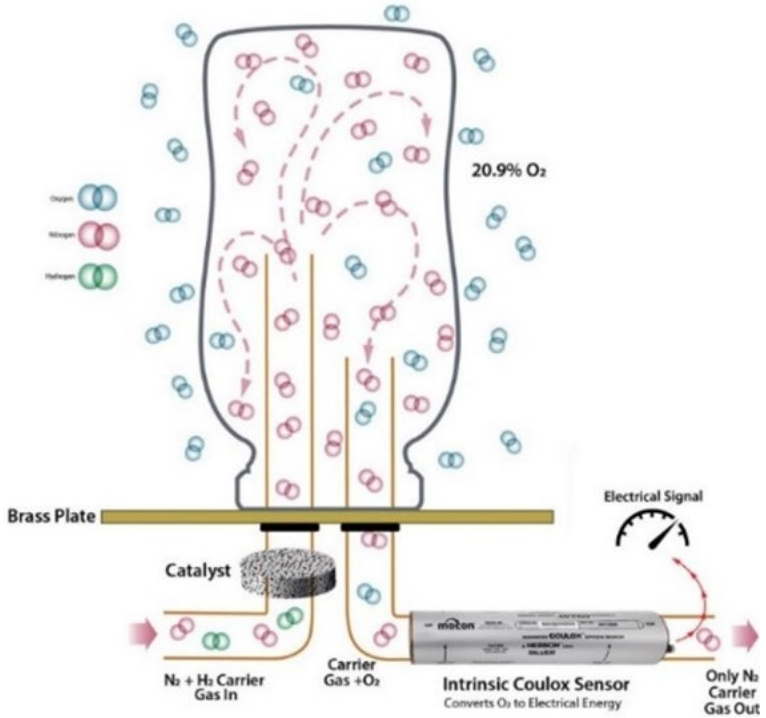
Measuring Oxygen Transmission Rate



Oxygen Permeation Analyzer



Images: Ametek Mocon

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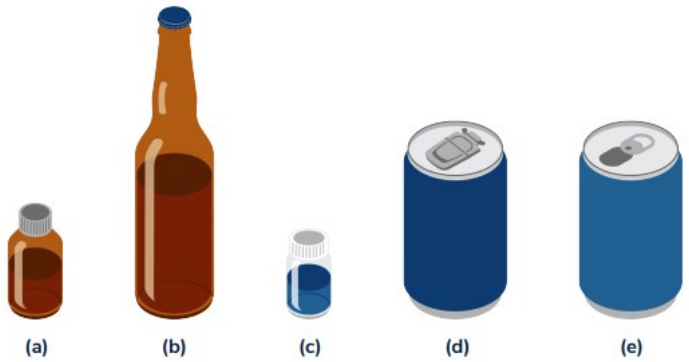
Measuring Oxygen Transmission Rate

Measured OTR of common beverage pack types



Sample	Mean Oxygen Transmission Rate (cc/pkg.day)	Std. Dev. (two replicates)
Glass with child resistant cap (a)	0*	0
Glass with crown cap (b)	0.01	0.01
Standard PET† with child resistant cap (c)	7.23	2.67
Can with childproof end (d)	7.23	1.51
Can with regular end (e)	0*	0

** Results were recorded as below the detection limit for the OTR analysis (≤0.00005 cc/pkg.day)*

† PET which does not contain oxygen scavenger

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Combining high and low OTR with model formulations in a stability study

Environmental Conditions

- Low OTR
- High OTR

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Combining high and low OTR with model formulations in a stability study

Environmental Conditions

- Low OTR
- High OTR

Formulation Variables

- No ascorbic acid
- Low concentration ascorbic acid
- High concentration ascorbic acid

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Experimental design

THC Emulsion

1.0L beverage was spiked to achieve a 20 mg per 355mL THC concentration

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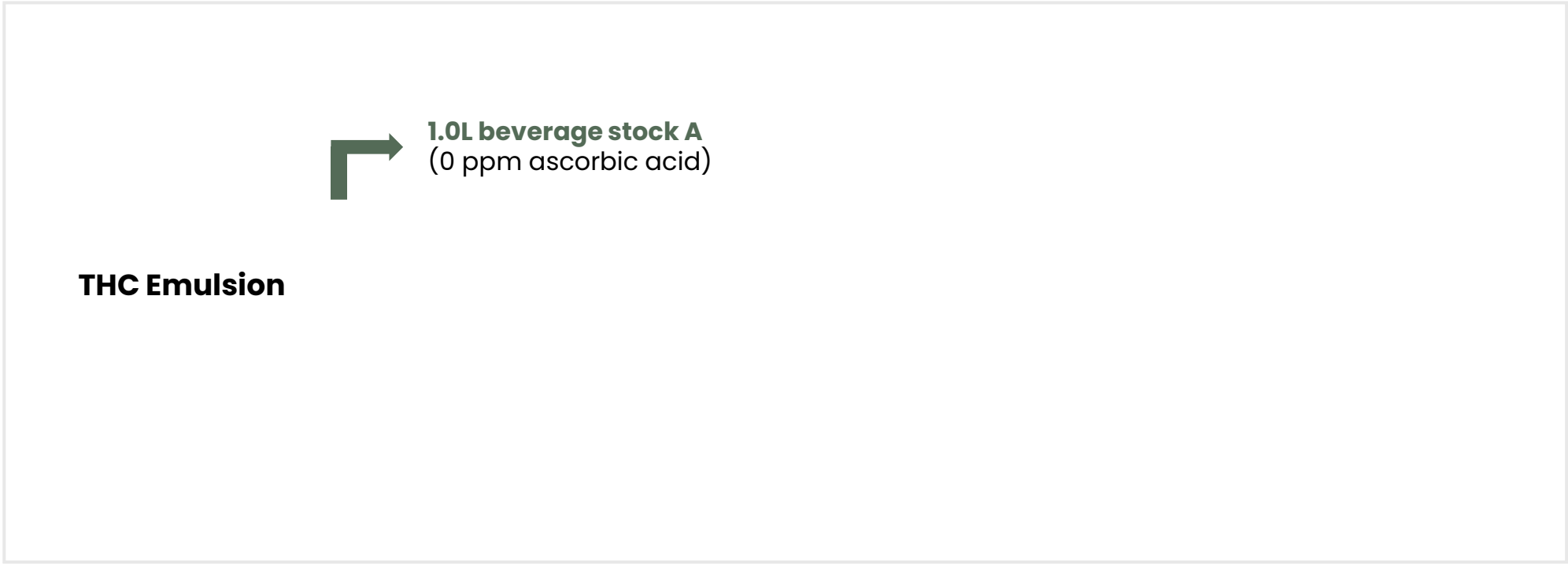
Experimental design



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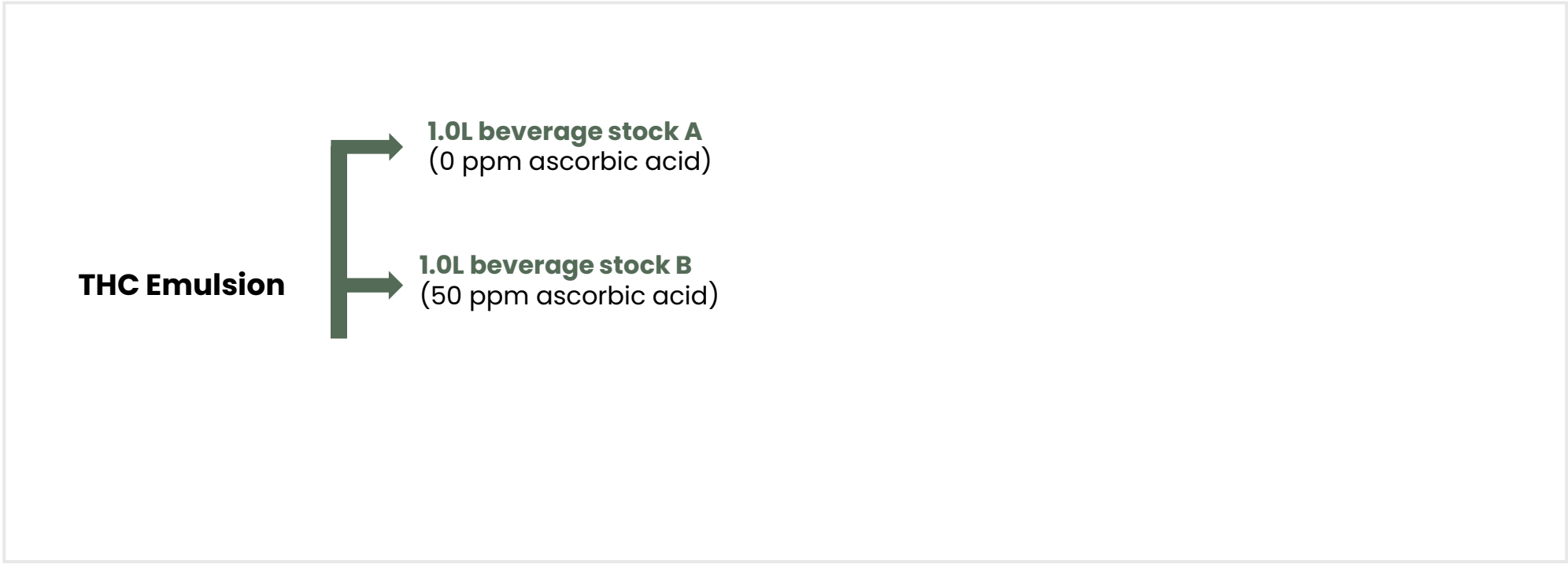

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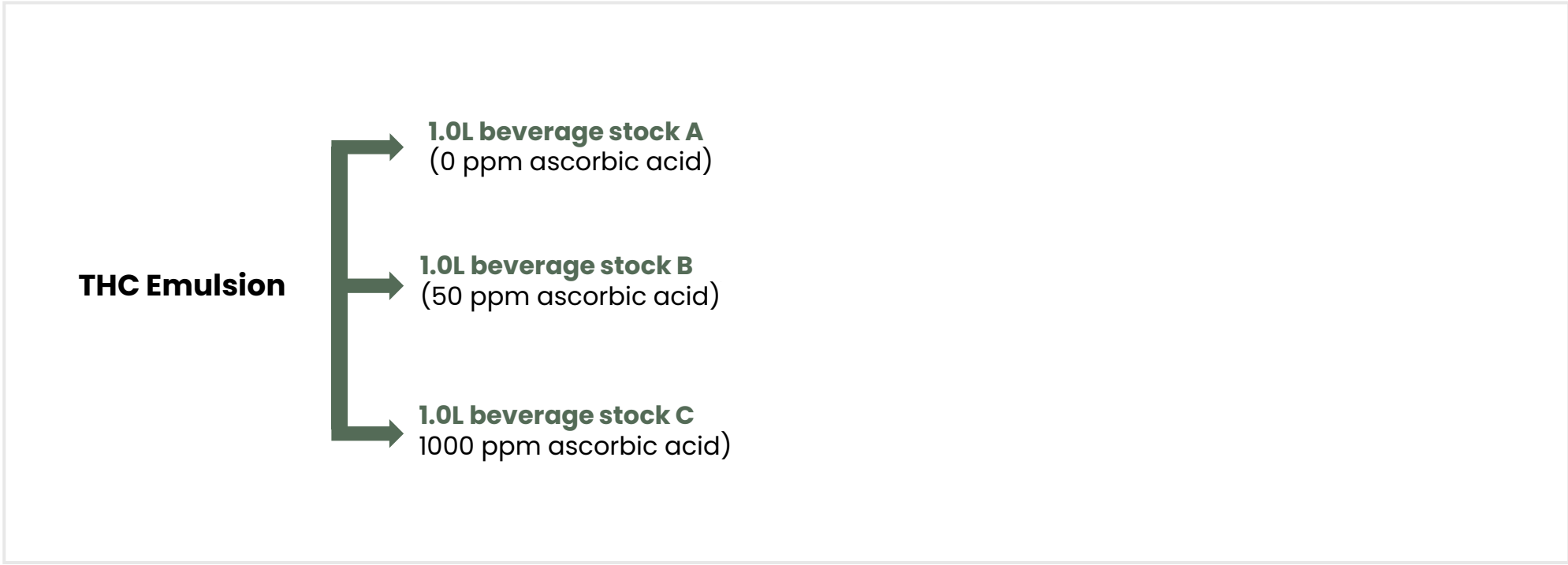

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Experimental design

THC Emulsion

- **1.0L beverage stock A** (0 ppm ascorbic acid)
- **1.0L beverage stock B** (50 ppm ascorbic acid)
- **1.0L beverage stock C** 1000 ppm ascorbic acid)

1.0L beverage was spiked to achieve a 20 mg per 355mL THC concentration

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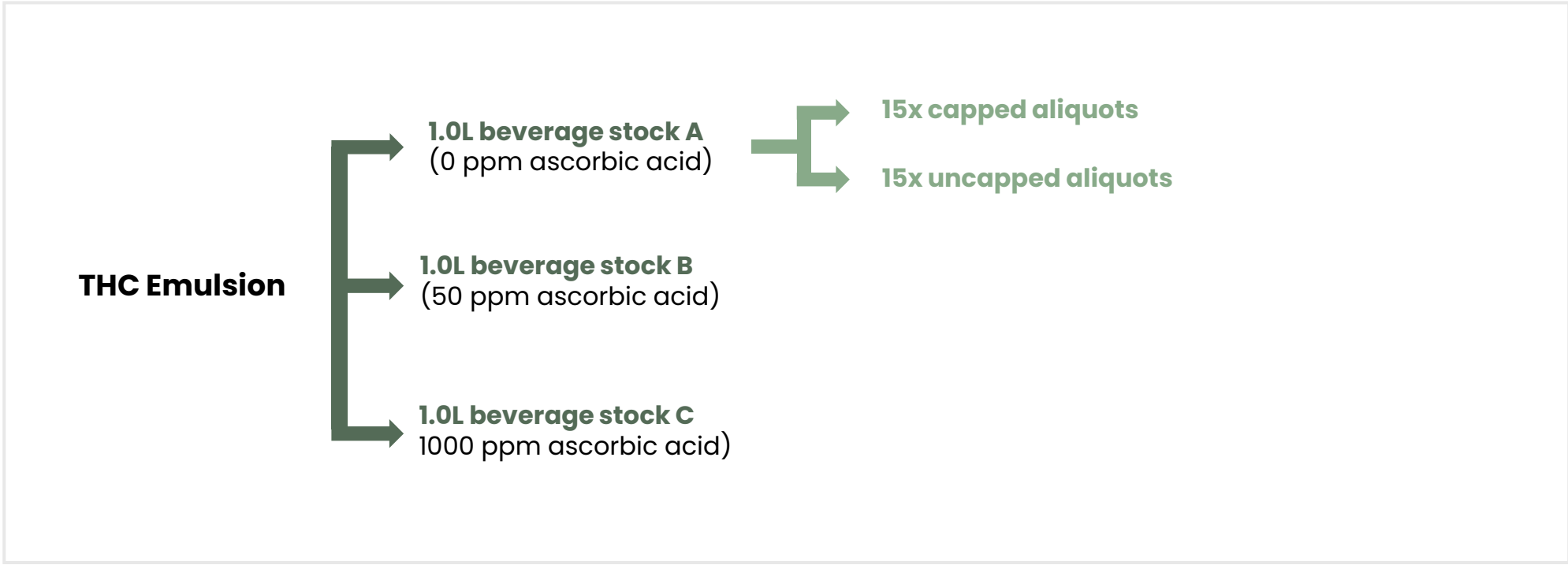
Experimental design



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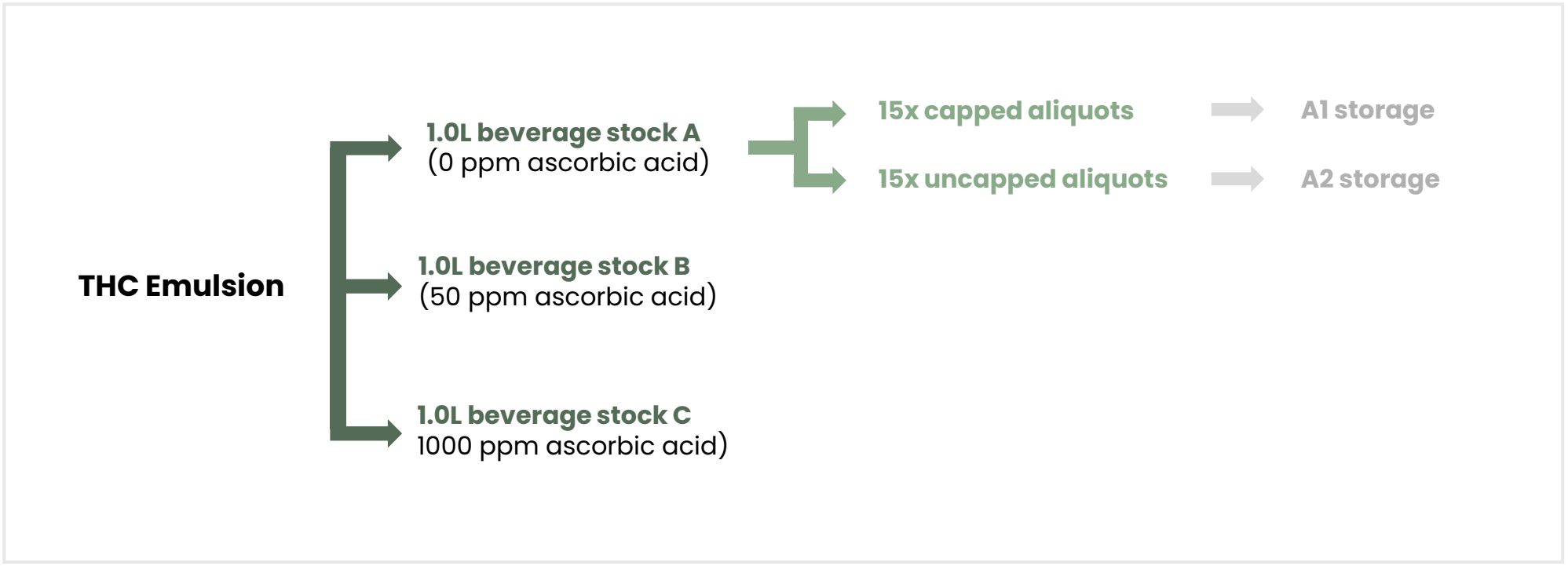

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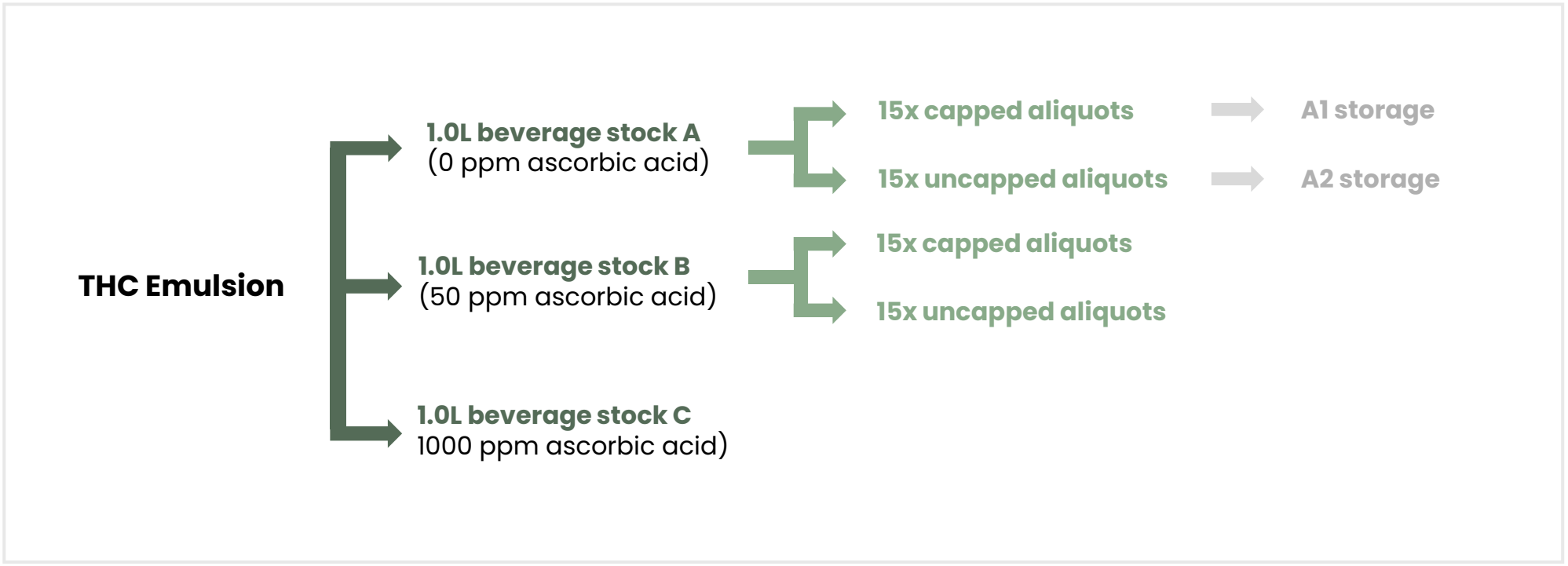

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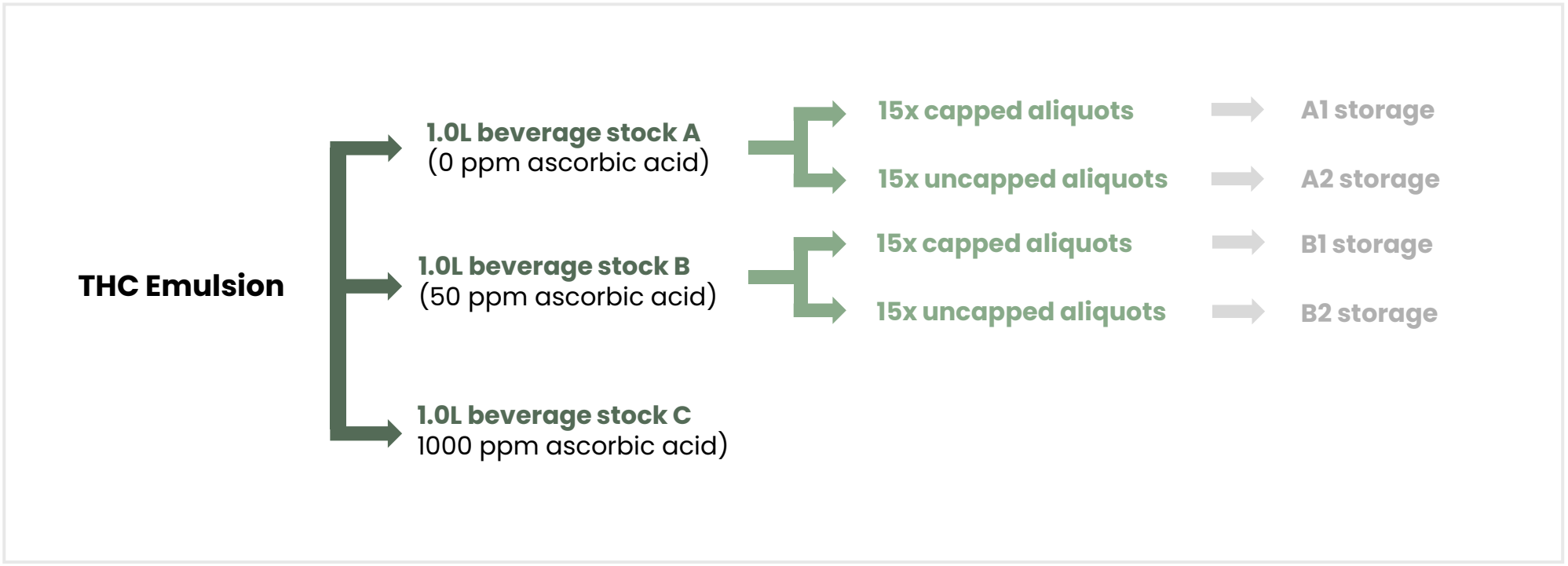

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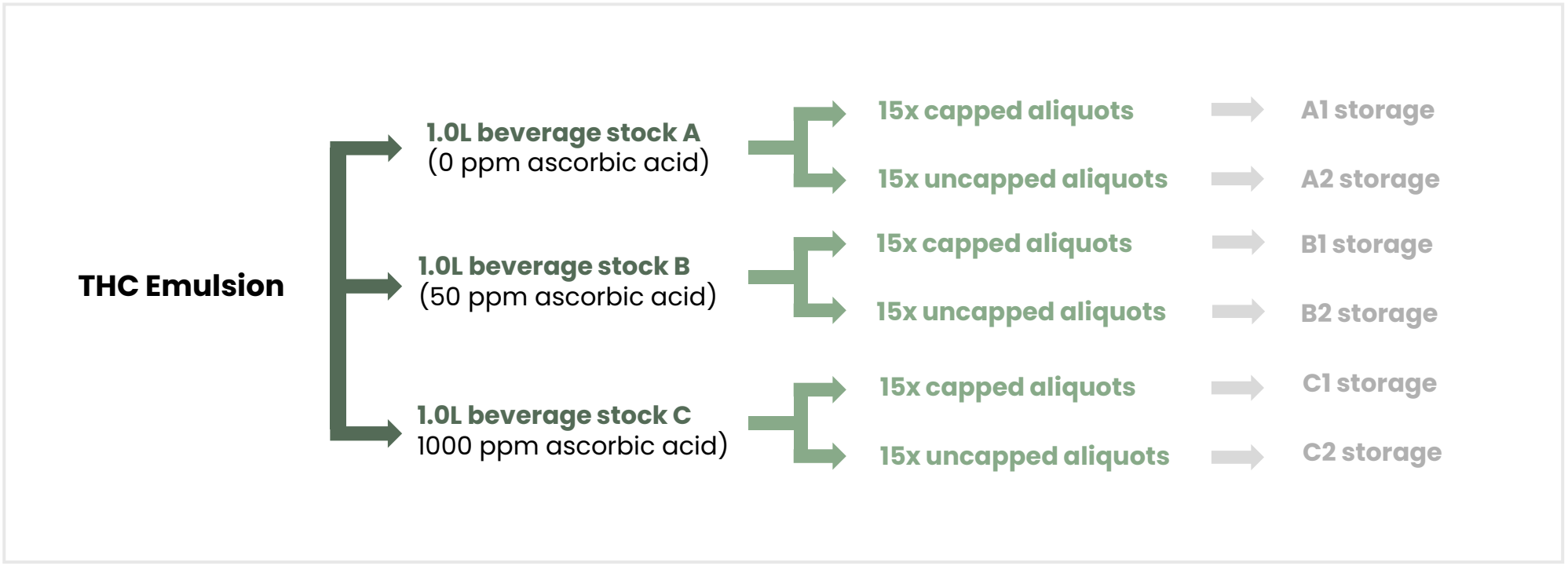

1.0L beverage was spiked to achieve a 20 mg per 355mL THC concentration

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Storage and sampling

Evaporation control and monitoring for uncapped samples was carried out by maintaining a water vapor saturated headspace. The water vapor saturated headspace was accomplished by filling a plastic storage container with ~1 cm of water and closing the lid (**Figure 3**). Uncapped samples were removed from the container and the lid was promptly closed following each sampling event. Throughout the course of this study, all three uncapped sample types (A2, B2, and C2) were found to have $Mass_{final}/Mass_{initial} \approx 1.00$, indicating no change in water mass from evaporation or condensation (**Figure 4**).

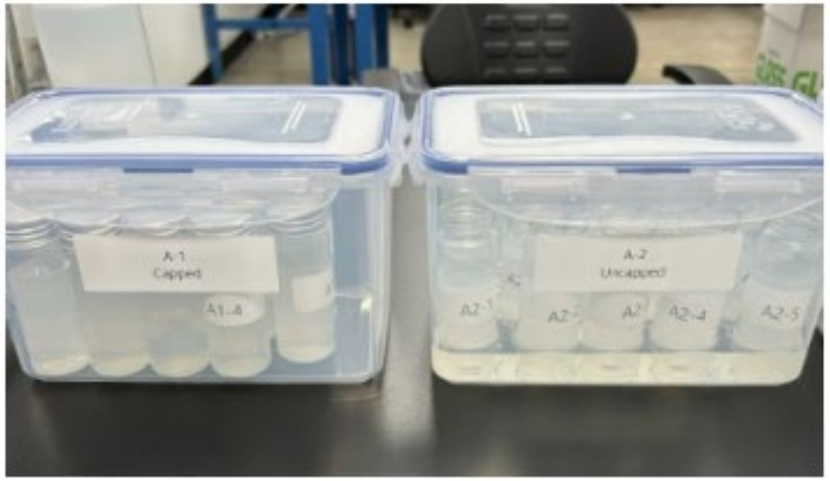

Figure 3. Comparison of capped vs uncapped sample storage conditions. Image showing A1 samples (left) stored with caps and no water in the container. A2 samples (right, uncapped) are stored with ~ 1 cm of water in the container in order to saturate the headspace.

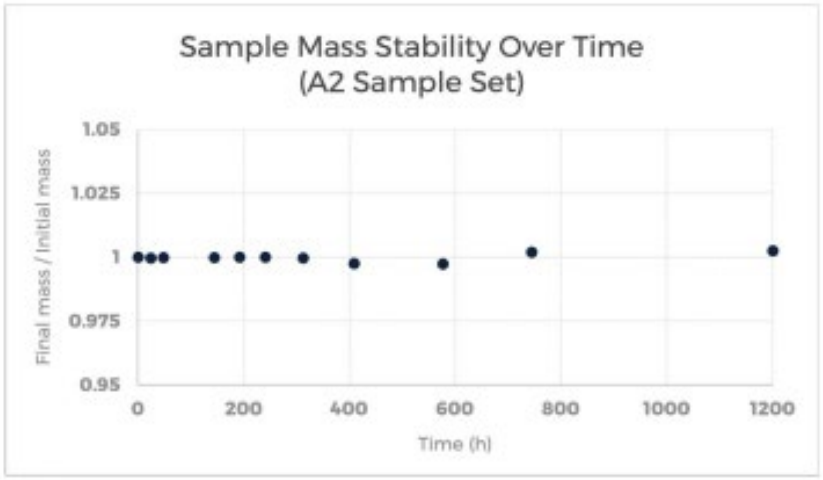

Figure 4. Sample A2 vial and sample masses over time. Samples B2 and C2 showed similar stabilities.

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Monitoring dissolved oxygen

Dissolved Oxygen

Dissolved oxygen concentrations were measured for each sample prior to potency analysis. Samples A1 and A2 (0 ppm ascorbic acid) showed relatively stable DO concentrations (7 ppm) from T = 0 h to T = 1200 h (**Figure 2**). Samples B1 and B2 (50 ppm ascorbic acid) DO values started near 7 ppm and at the 24 h mark fell below 6 ppm. After the apparent consumption of ascorbic acid, the DO values climbed up to 7 ppm where they remained for the duration of the experiment. Samples C1 and C2 (1000 ppm ascorbic acid) are of great interest because DO values fell below 4 ppm and remained lower than the A and B series samples for the remainder of the experiment. Interestingly, samples C1 and C2 show a difference in their DO concentrations at 192 h, 4.9 vs 6.1 ppm DO, respectively. This finding suggests that ascorbic acid may have been consumed at a faster rate for sample C2 (uncapped) than sample C1 (capped).

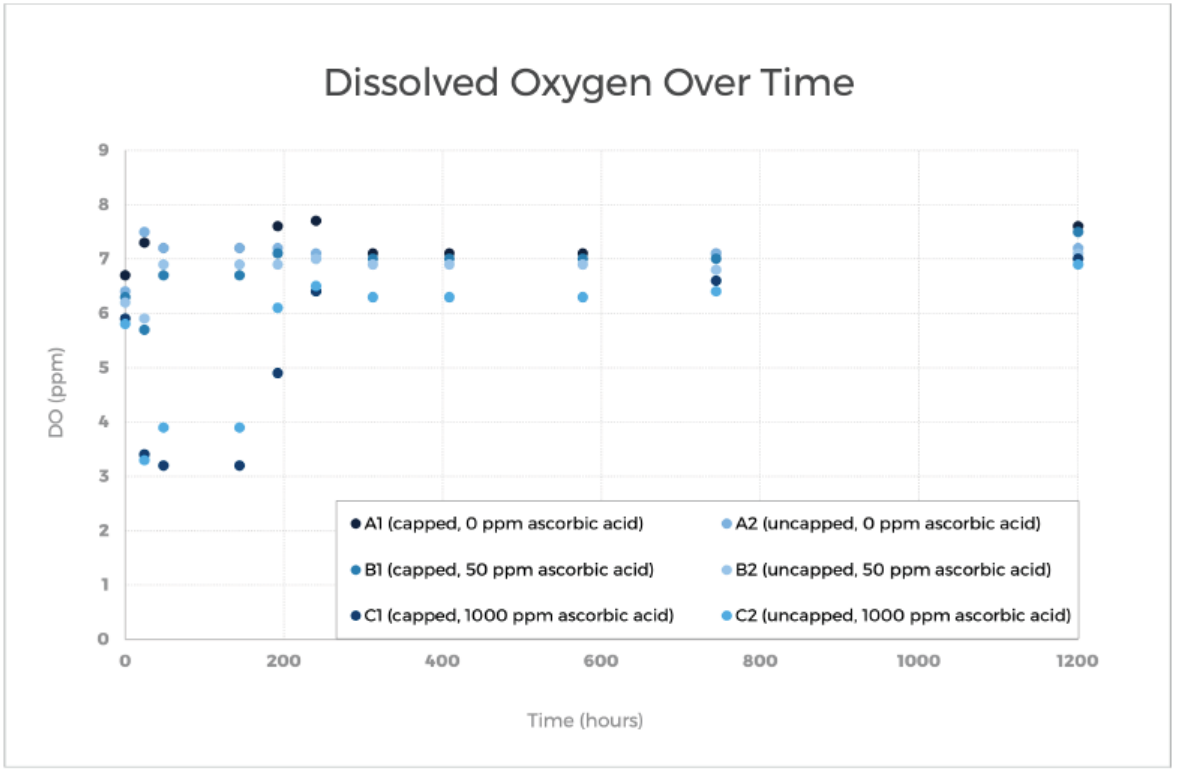

Figure 2. Dissolved oxygen over time for all samples.

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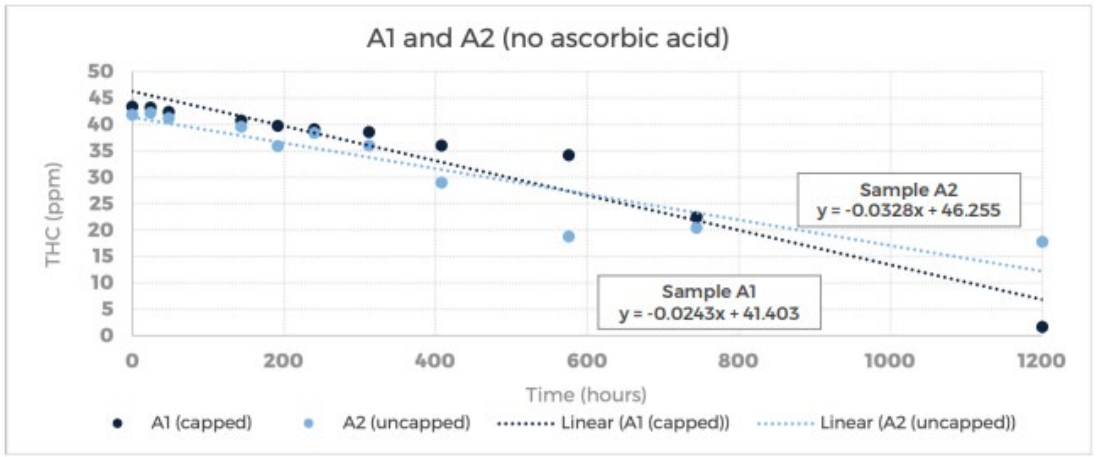
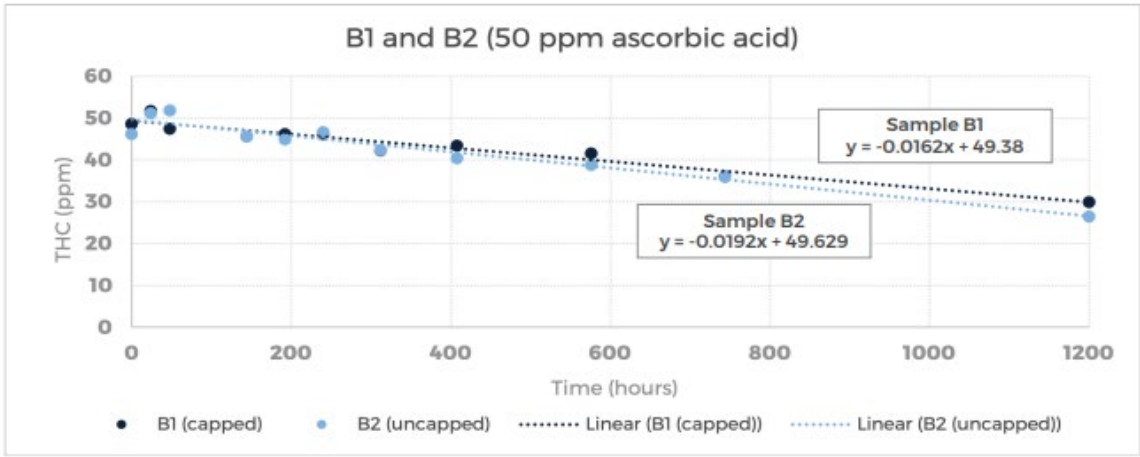
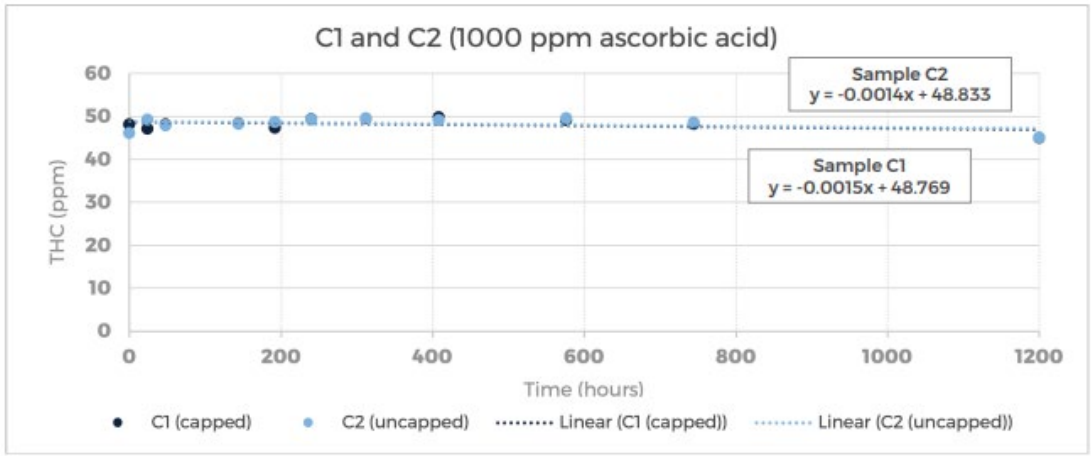
Potency over time







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Potency over time

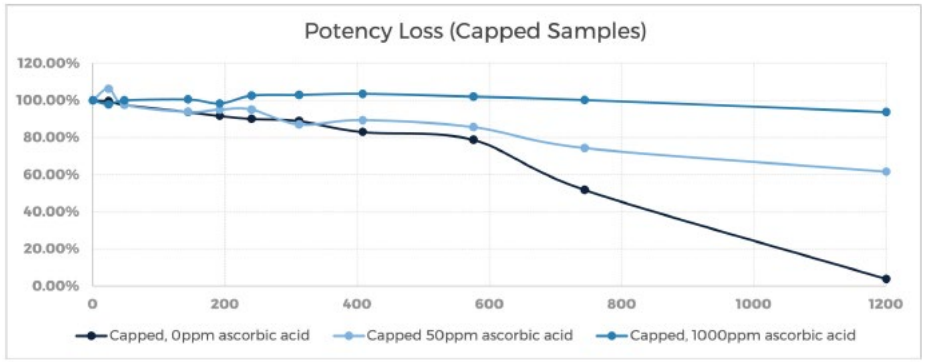

Figure 8. Potency tracking over time for uncapped samples.

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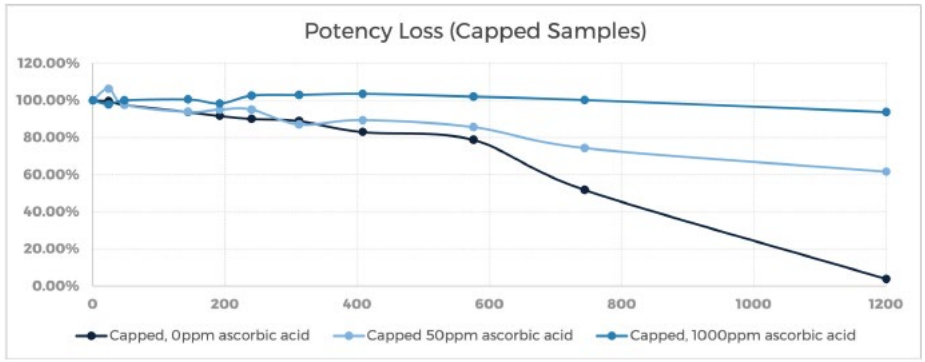
Potency over time



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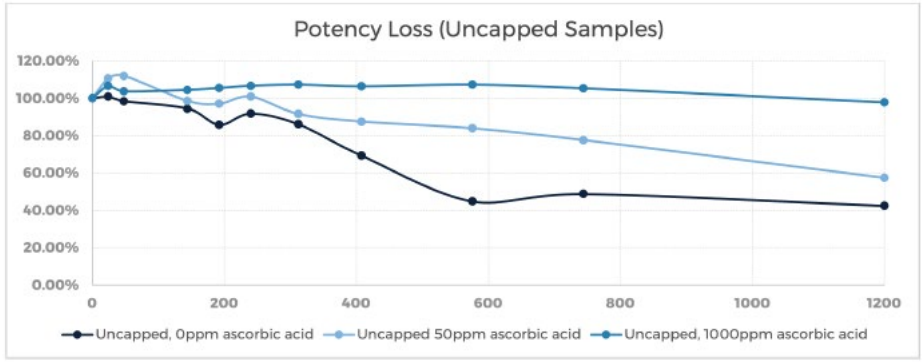

Figure 9. Potency tracking over time for capped samples.

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The takeaway/ considerations

01 What does the data indicate?

02 What are the study limitations?

03 What are the future directions?

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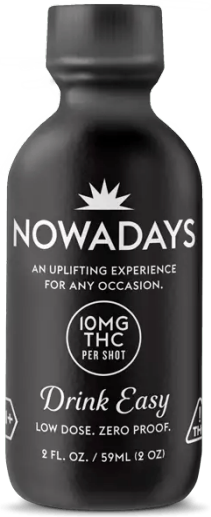
Study Impact to 2oz shot



Study Impact to 750mL Format

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Q and A

Oxidation Rate of Different Cannabinoids in Beverage Form

Cannabinoids in same type of emulsion Diluted to 20 mg / 12 oz in water, ambient oxygen level	**40°C Week 1** Potency loss %	**40°C Week 2** Potency loss %
THC	-58.73%	-90.73%
THCv	-67.37%	-96.98%
CBD	-30.37%	-51.26%
CBG	-30.08%	-59.57%
CBC	-6.59%	-8.58%
CBN	-2.50%	-4.84%

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