Understanding, Modulating and Optimizing Drying and Curing

Allison Justice, PhD, VP Cultivation
Markus Roggen, PhD, VP Extraction
OutCo, San Diego

Post-Harvest: INDUSTRY GUESSES…

- To remove moisture & to make smell better.

BUT WHY????

Drying: To prevent spoilage

Curing: Homogenization

AND HOW?????

Removal of chlorophyll? Convert starches to sugars? Exchange of gasses? Homogenization?

Once we find out what is happening we can optimize to speed up the process…

Plant Harvest Physiology- Important Terms

- **Transpiration**: Process by which plants and plant parts lose moisture through the transport of water through the skin, evaporation of this water from the plant surface, and convective mass transport of the water to the surroundings.

- **Respiration**: Chemical/enzymatic process by which fruits and vegetables convert sugars and oxygen into CO2, water and heat.

How does cannabis fit into plant post-harvest physiology research?

Let's compare…

- Fruits & Vegetables
- Cut flowers
- Transportation of unrooted cuttings (to be propagated)

GOAL: to delay death, preservation, delay ripening in order to consume, decorate or propagate.

HOW: By slowing down respiration and transpiration. Putting the plant/plant organ into stasis.

Method: Cool temperatures, inhibition of ethylene perception by applying 1-methylcyclopropene, and high humidity.

Drying

- Prevent immediate spoilage (prohibit microbial growth/germination)
- Extend shelf-life
- Dry slow enough to NOT volatilize terpenes
- Provide a nice smoke/ be appealing to consumer

Dry Room Conditions

- 60-74˚F
- 40-60% humidity

Factors influencing microbial growth

Water activity

Temperature

pH

Microorganisms have a limiting water activity level below which they will not grow. Water activity (AW), not moisture content, determines the lower limit of “available” water for microbial growth. Since bacteria, yeast, and molds require a certain amount of “available” water to support growth, harvesting at the proper AW is crucial.

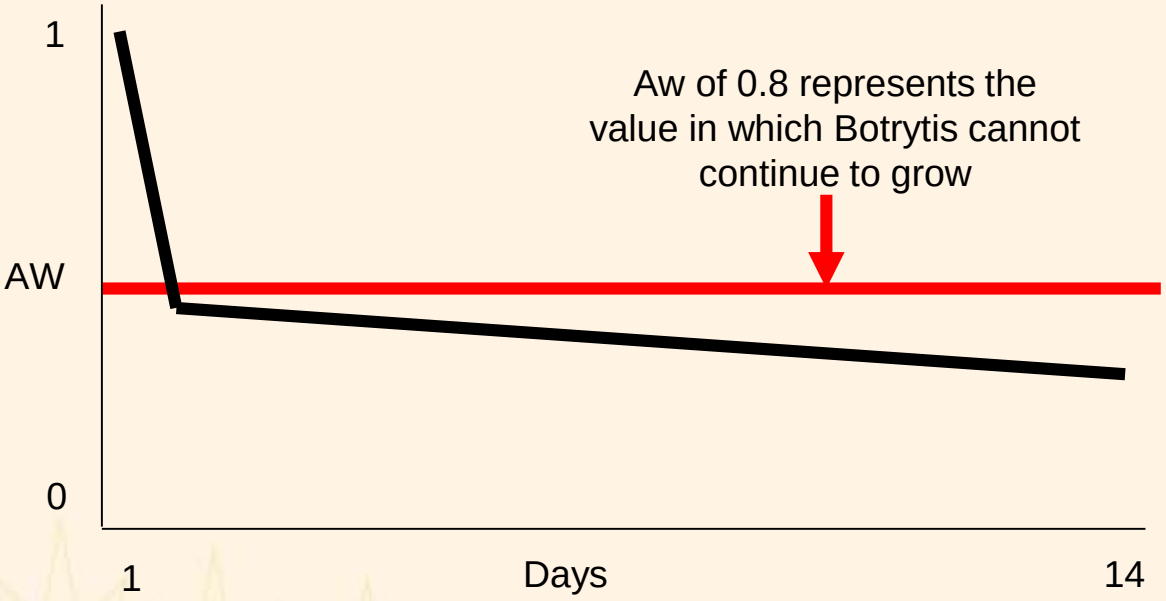
(Range= 0-1)

outco

Table 1. Water activity ranges of common foods and the microorganisms of concern in those a_w range

a_w	Microorganisms of concern			Foods in this a_w range
	Bacteria	Mold	Yeast	
0.95-0.97	+	–	–	Fresh meat, fruit, vegetables, canned fruits, canned vegetables, cooked sausage
0.90-0.94	+	+	+	Some cheese, cured meat (ham), evaporated milk
0.87-0.89	+	-	+	Sweetened condensed milk, aged cheeses, dried meats, bacon, chocolate syrup, fondant
0.80-0.85	-	+	+	
0.71-0.79	-	+	-	Jam, marmalade, marzipan, molasses, dried figs
0.60-0.70	-	+	+	Dried fruit, corn syrup, marshmallow, chewing gum
0.00-0.60	-	-	-	Caramels, toffee, honey, cocoa, crackers, dry mixes, boiled sweets, milk powder

Water Activity during Dry and Cure

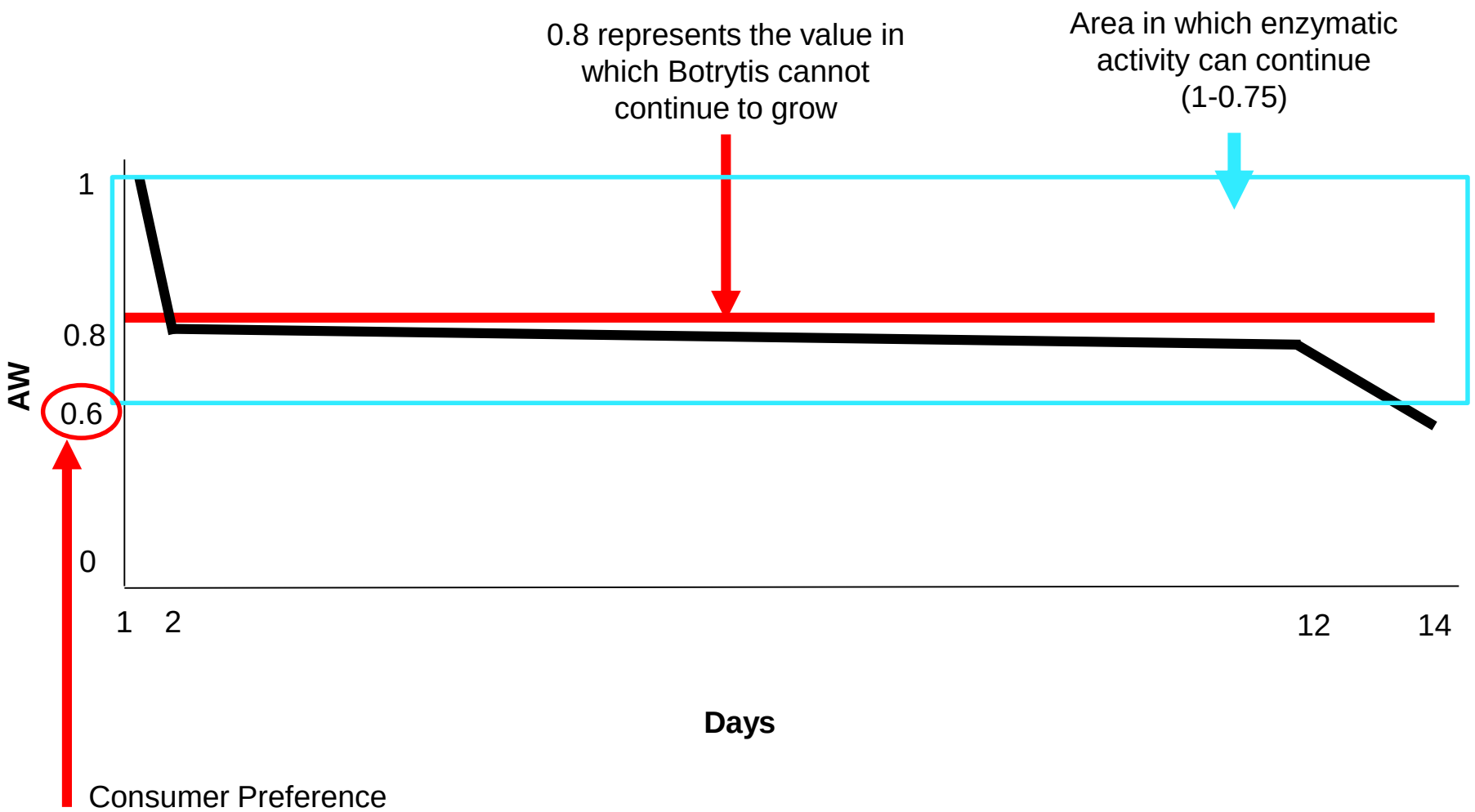


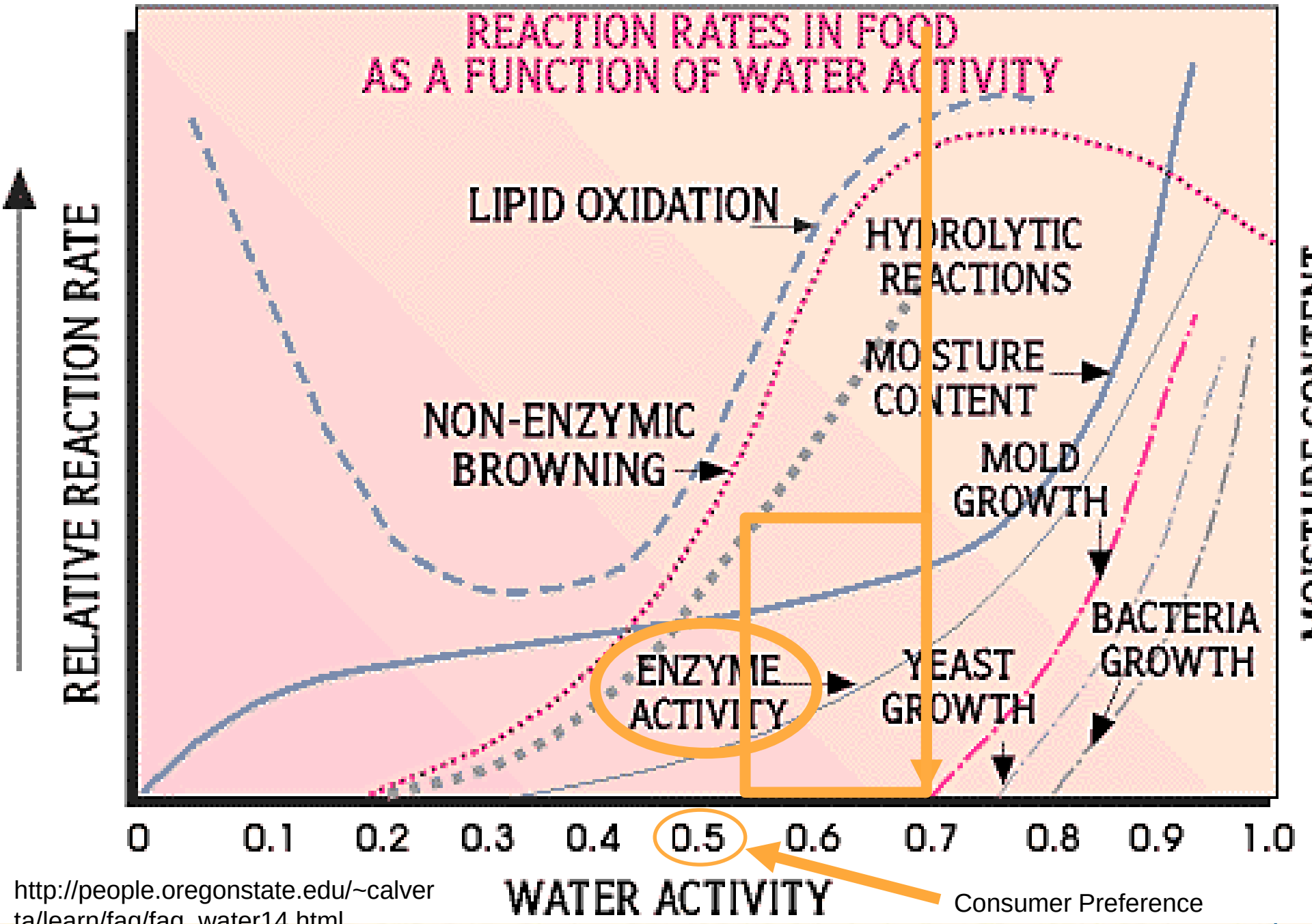
Terpene Content (% dry weight)		
	Rapid Dry	**Slow Dry**
Lemonade Haze	1.42	1.82
Sour Tangie	1.69	2.2

- Balance between inhibiting microbe growth and terpene loss

Water Activity during Dry

outco





http://people.oregonstate.edu/~calverta/learn/faq/faq_water14.html

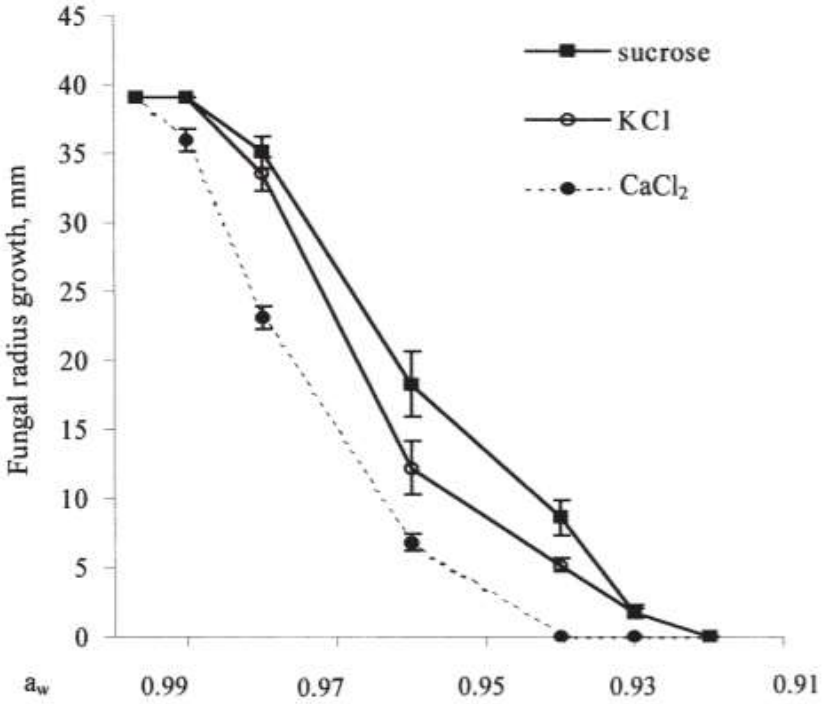


Fig. 3: Influence of water activity (a_w) and amendments to media on the *in vitro* growth of *B. cinerea*. Cultures were performed on PDA media pH 7 at 20 °C for 5 d. Plotted values are means ± s.e. (3 replicates).

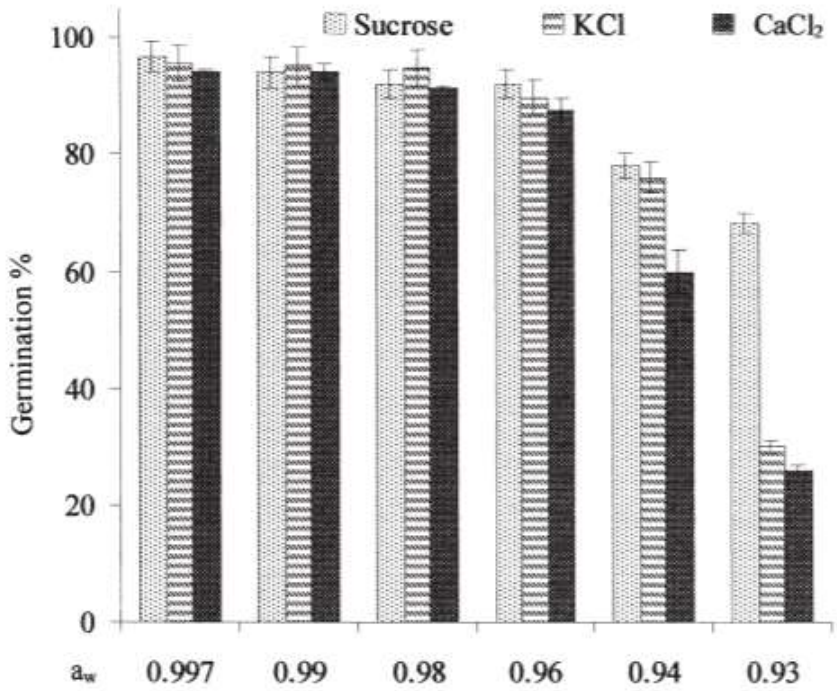


Fig. 4: Influence of water activity (a_w) and amendments to media on germination of *B. cinerea* conidia after 24 h incubation at 20 °C. Plotted values are means ± s.e. (3 replicates).

Vitis **40** (2), 75–78 (2001)

Effects of water activity (a_W) on the growth of some epiphytic micro-organisms isolated from grape berry

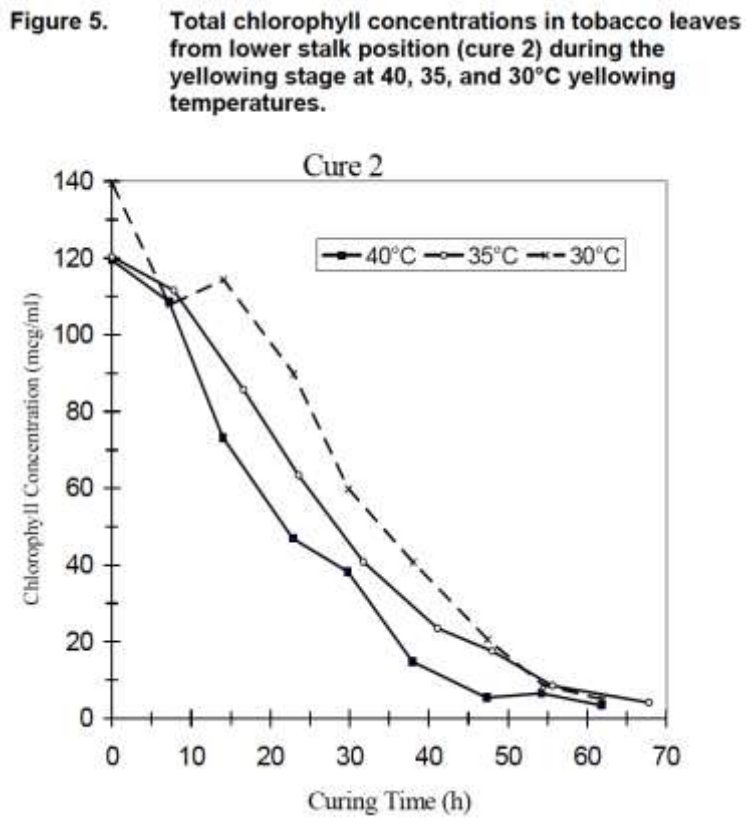
SOPHIE ROUSSEAU and B. DONÈCHE

Curing

Curing Conditions

- Different containers
  - bucket, glass, box, bag…
- Ambient conditions
  - 40-50% humidity, 70˚F
- Length of time
  - At least 1 week, up to 3 month

Curing of Tobacco



- Curing is necessary for flavor and smokability
- Aim is to reduce chlorophyll content, aka color curing
- Balance of ‘alive’ for yellowing and ‘dying’ for wilting
- Finally, leaves are ‘killed’ to stop chemical and color changes

Figure ref.: Tobacco Science (2000) 44:51-58

Curing of Tobacco

Flue Cure

- Approx. 1 week in barn with external heat source
- High in sugar and nicotine

Air Cure

- 4 to 8 weeks in well-ventilated barns
- Low in sugar, high in nicotine: Cigars

Fire Cure

- 3 days to 10 weeks in barn with smoldering hardwood fire
- Low in sugar, high in nicotine: Pipe, chewing

Sun Cure

- For oriental tobacco, high in sugar and low in nicotine

****Not worried about preserving terpenes****

Chemistry of Curing Tobacco

- Dominated by hydrolytic enzymes, e.g. starch to sugar
- Degrading carotenes negatively influence flavor

Success depends on:

- Leaf maturity
- Temperature
- Humidity
- Water content of leaf

Aging of Wine

- Wine is made by fermenting grape sugar to ethanol
- Wine's aroma comes from chemical changes during winemaking and wine storage
- Nearly 9000 components were assigned
- Part-per-trillion concentrations of certain compounds can affect flavor

How does cannabis compare??

outco

&

LEGACY US

The Burp Project

Plant Material:

- Mendo Breath & Tangimal

Treatments:

- Control (no burp)
- OutCo Burp: for the first three days lids will be removed for 15-20 minutes and flower turned
- Industry Burp: lid opened daily for 1 hour for two weeks and flower turned

Data Collected: CO2, RH, Temp & AW

The Burp Project: CO2

&

LEGACY US

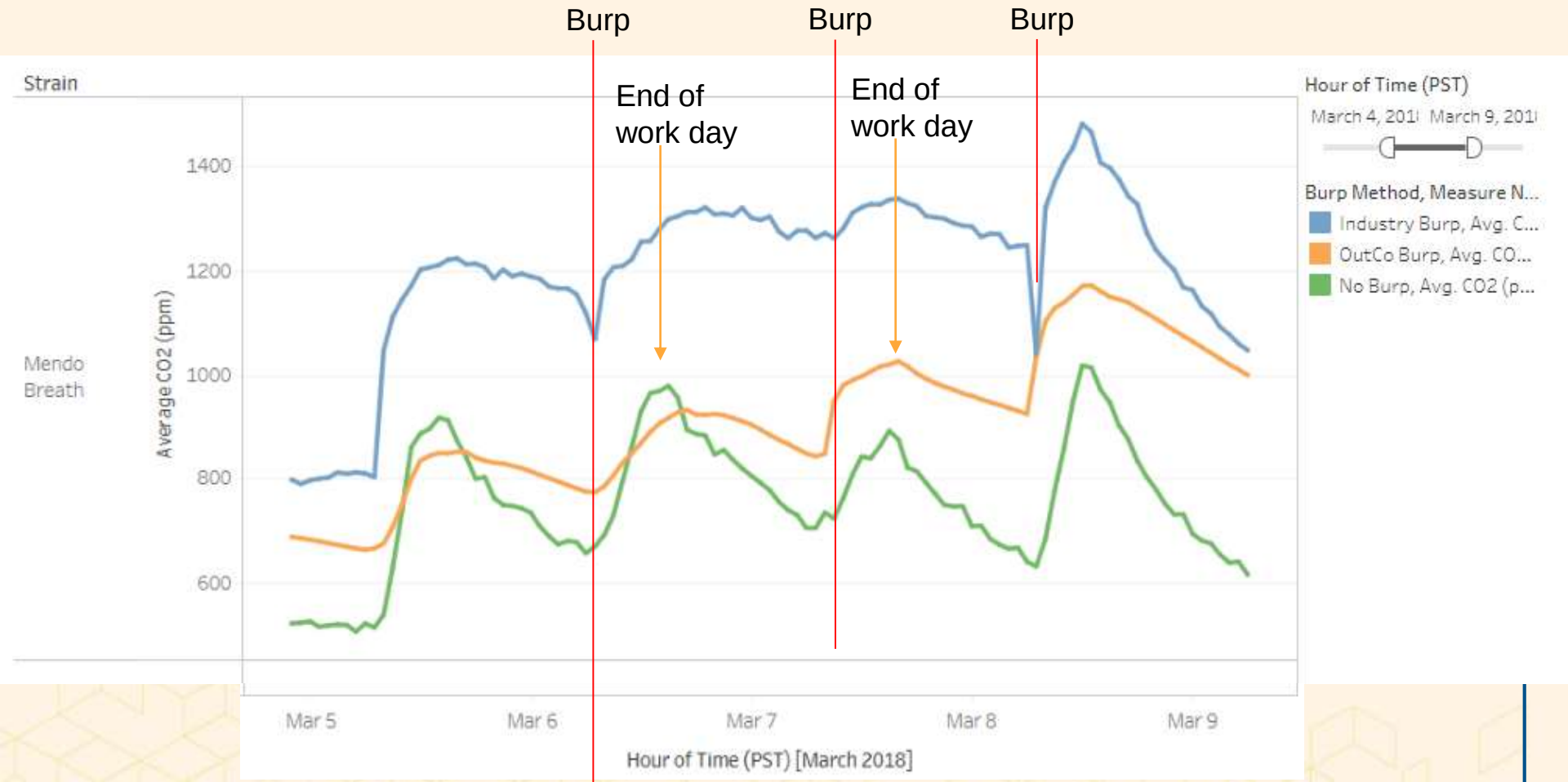
- In general, CO2 builds over time
- A burp releases CO2 and instantly encourages the buildup of CO2
- Industry burp, although longer, immediately and most drastically increases CO2.
- Allowing in more O2 for respiration?

outco

&

LEGACY US

The Burp Project: CO2

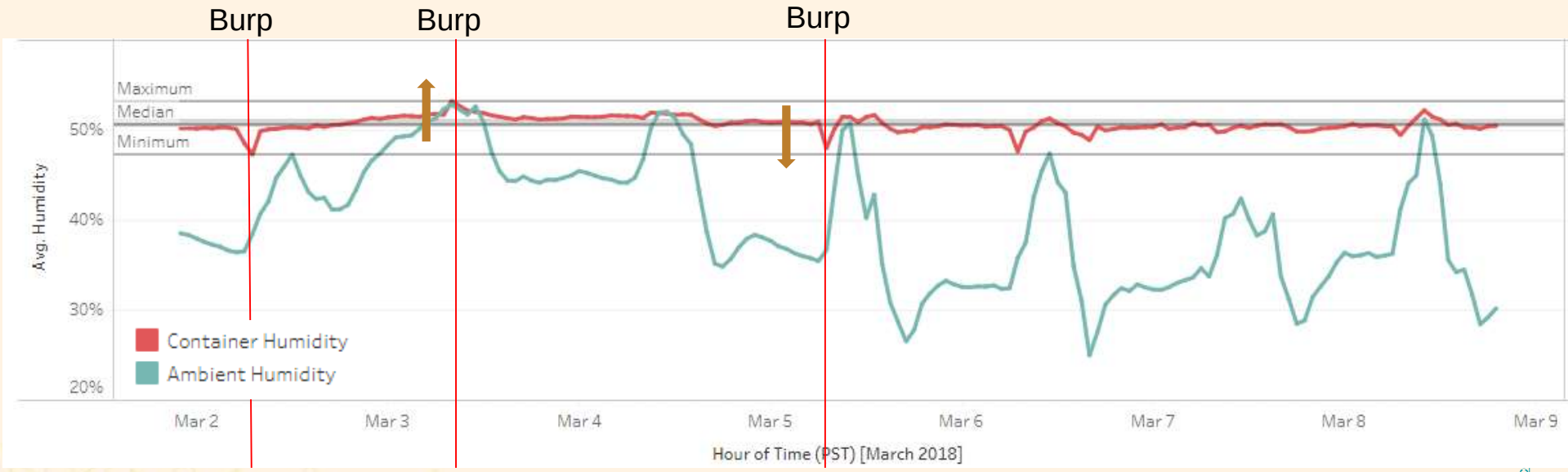


outco

&

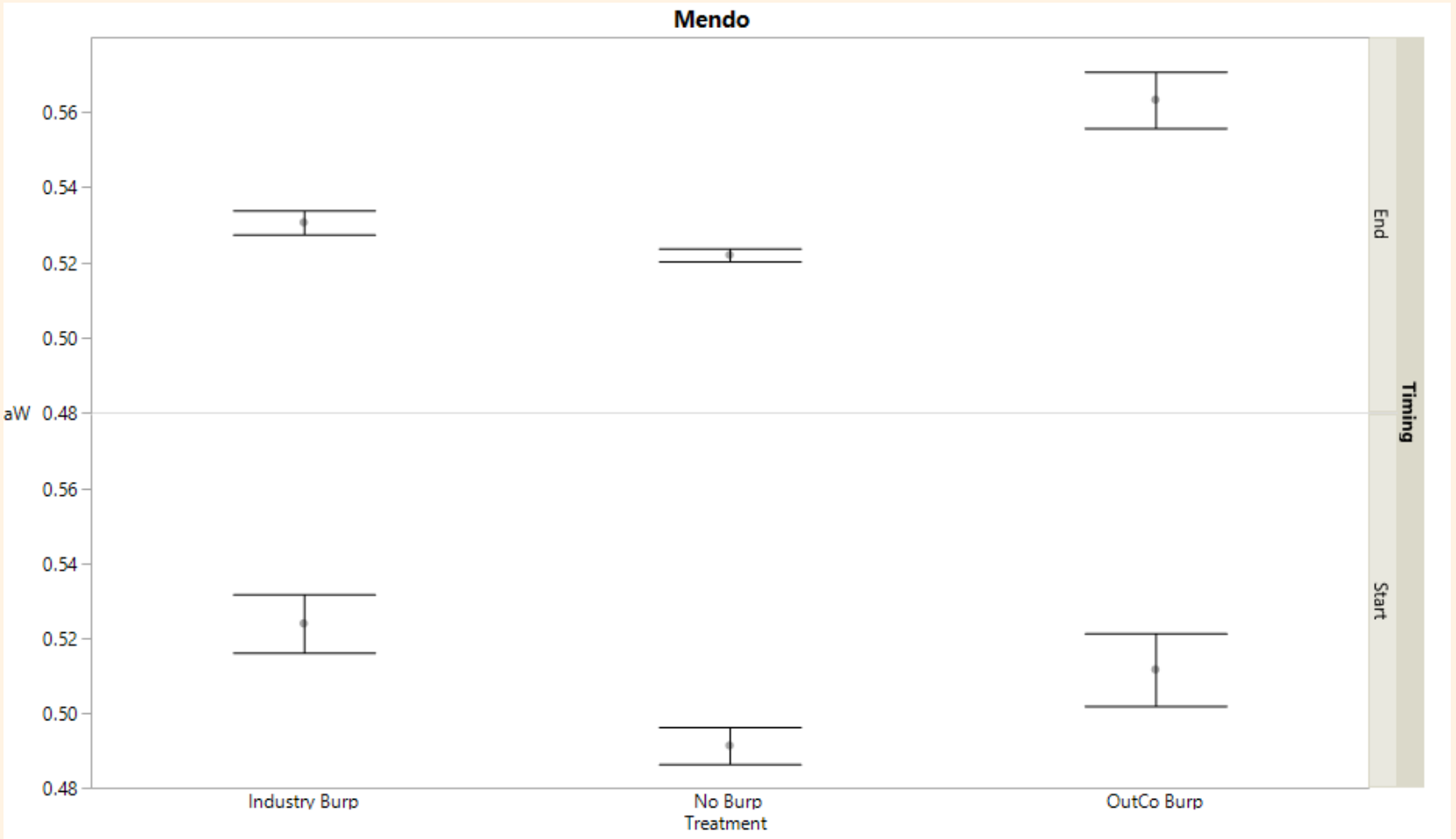
LEGACY US

The Burp Project: RH



Conclusions:

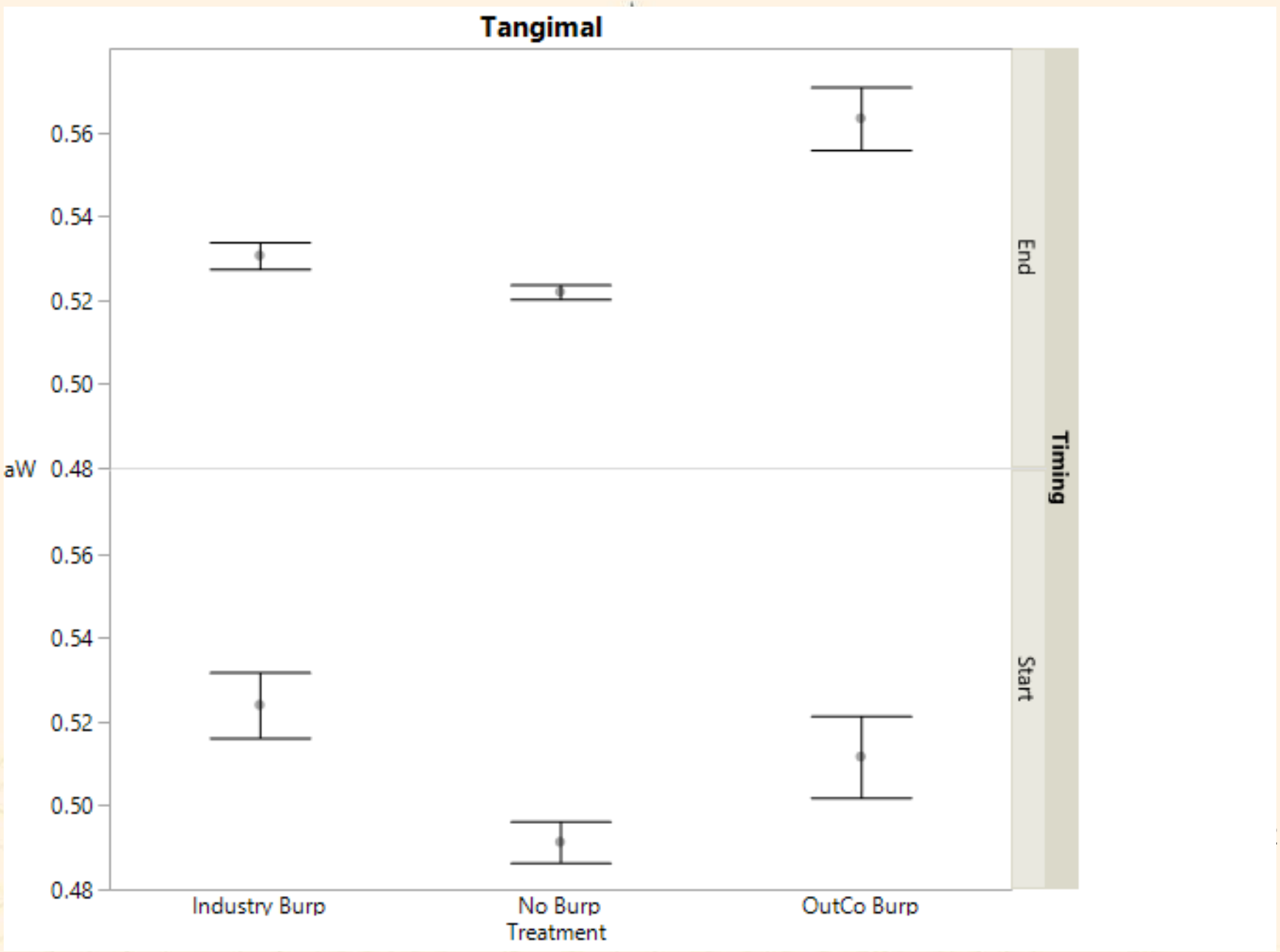
- The burp is not a release of moisture
- A burp causes a temporary change in bucket humidity which is related to the room humidity
- Once the bucket is closed, humidity returns close to starting reading



Starting and ending Aw.

Each data point represents the average of three samples with error bars representing the standard deviation.

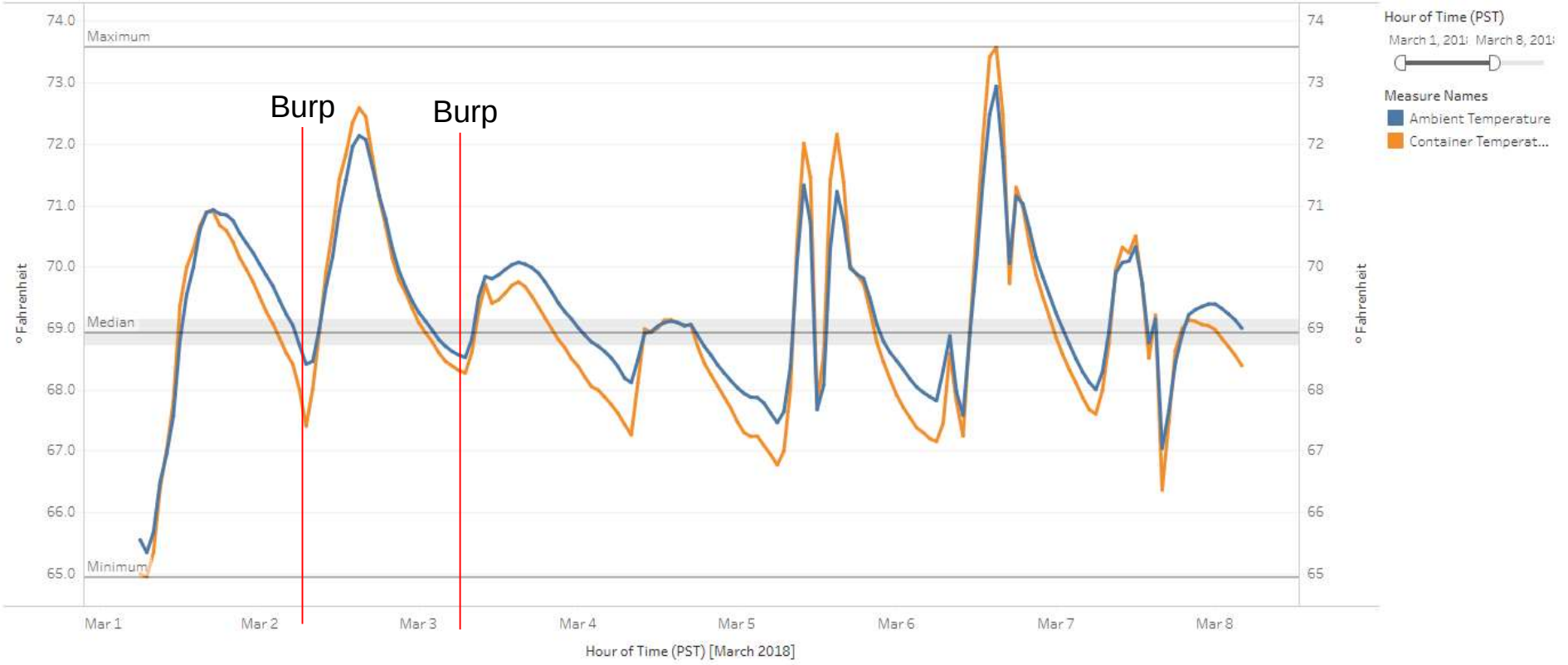
Notice the decrease in variance from start to end of samples. Also notice that the samples are getting “wetter”. Does this represent homogenization?



outco

NATE CONTROLS™

The Burp Project



Temperature in the bucket is directly related to the temperature in the room.

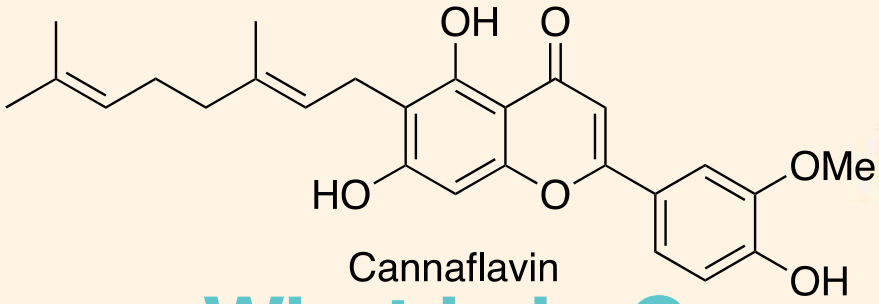
Take away…

Plastic buckets are NOT gas tight.

With burp treatments tested, RH in bucket stays consistent throughout cure.

AW increases over time.

Temperature follows room trend.



Cannaflavin

What is in Cannabis to a Chemist?

~30 Flavonoids

So many molecules we should keep track of

Carbohydrates, Fatty Acids

Alcohols, Phenols

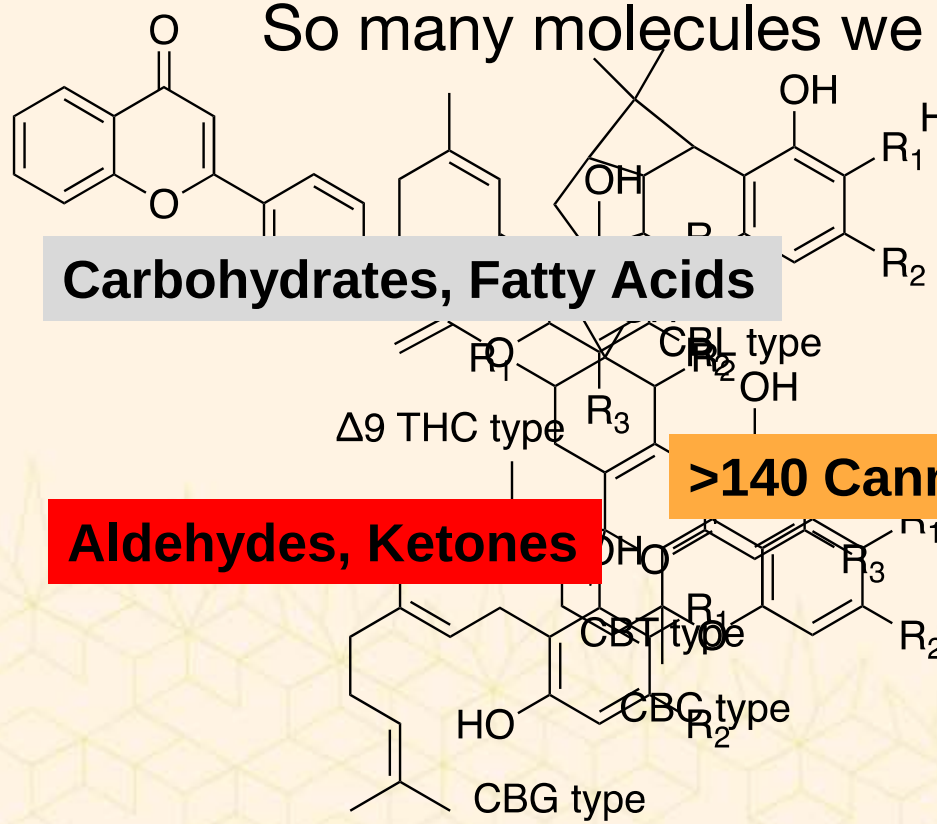
Lactones

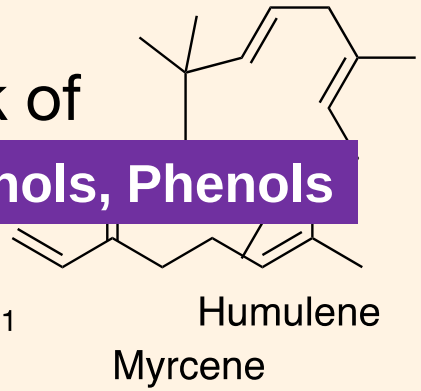
>140 Cannabinoids

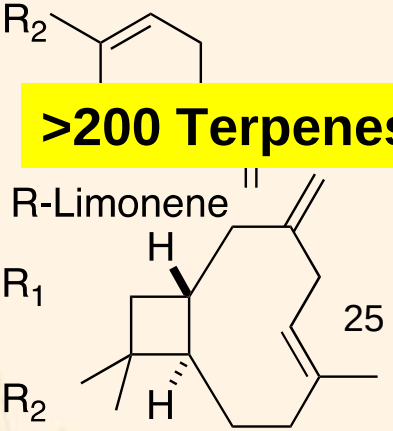
>200 Terpenes

Aldehydes, Ketones

Alkaloids

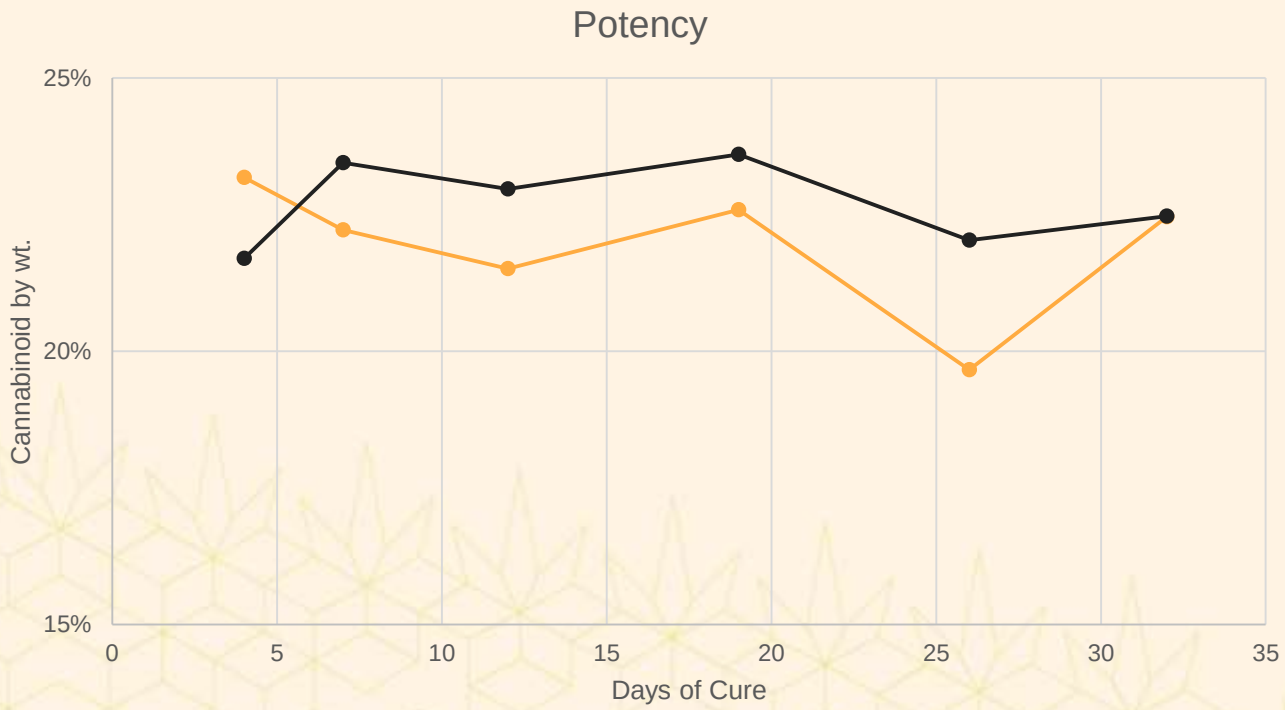






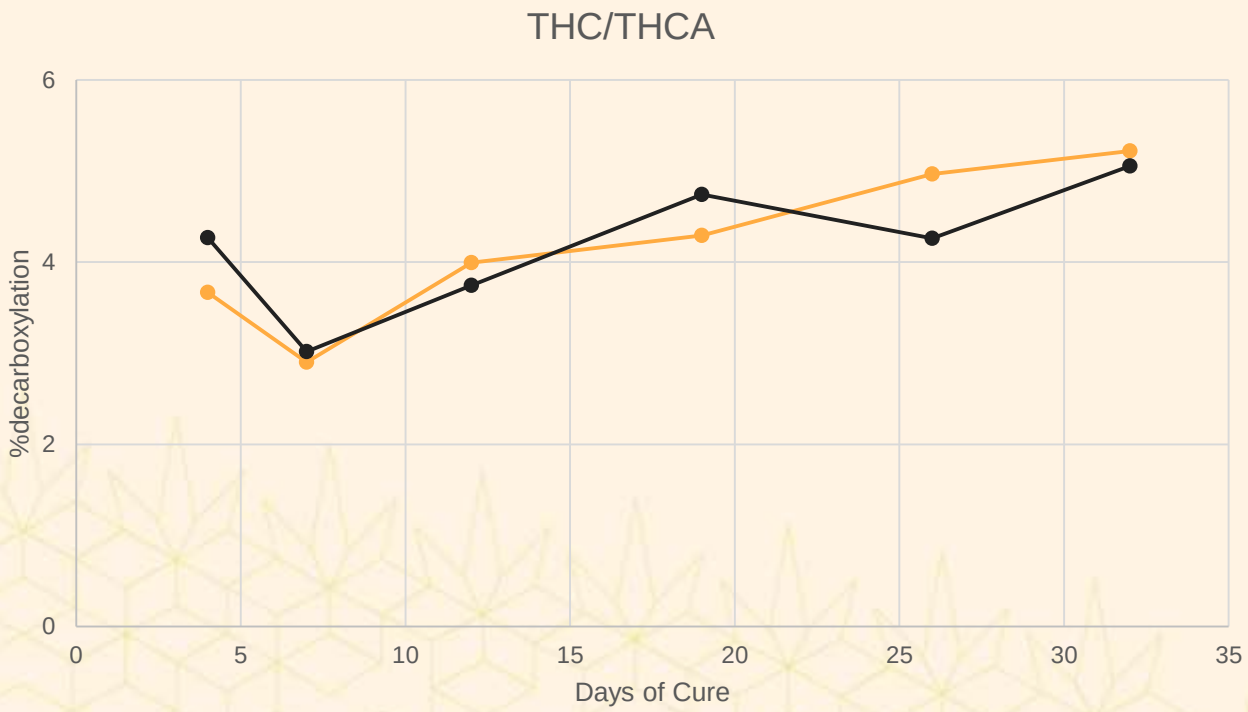
Cannabinoids during Cure

Does anything happen to THC, CBD, …?

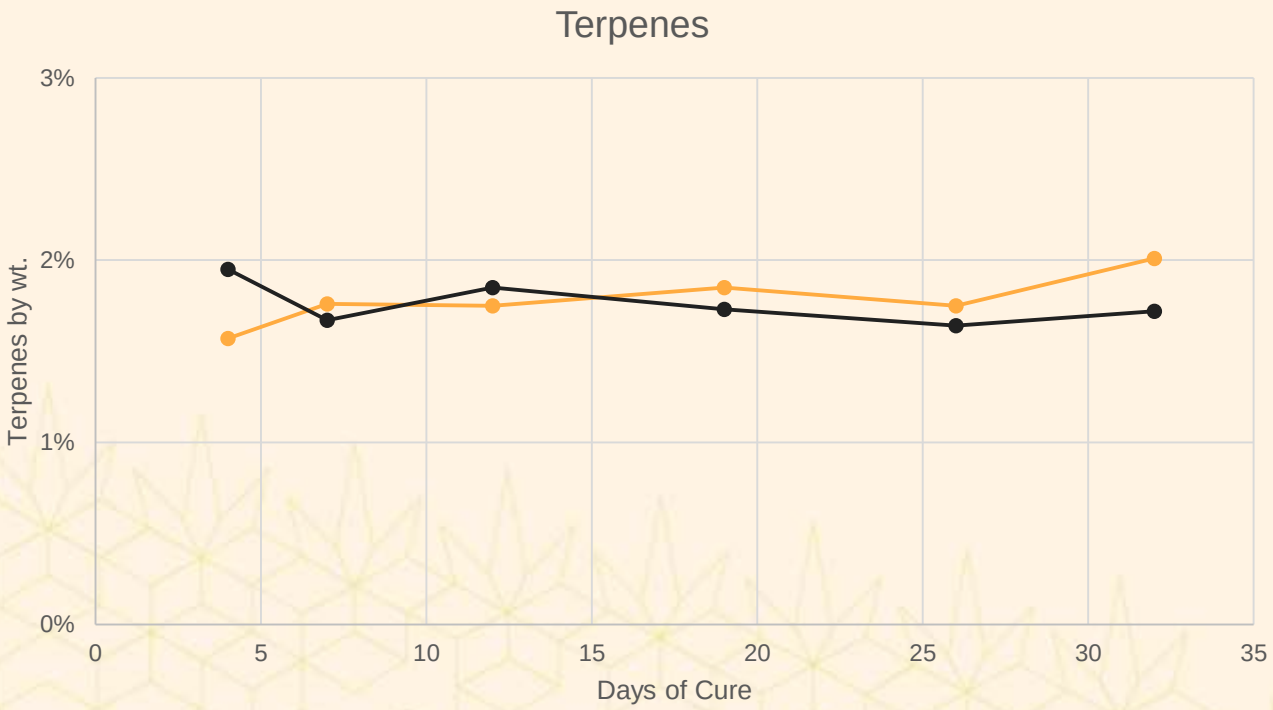


Cannabinoids during Cure

Does anything happen to THC, THCA, …?

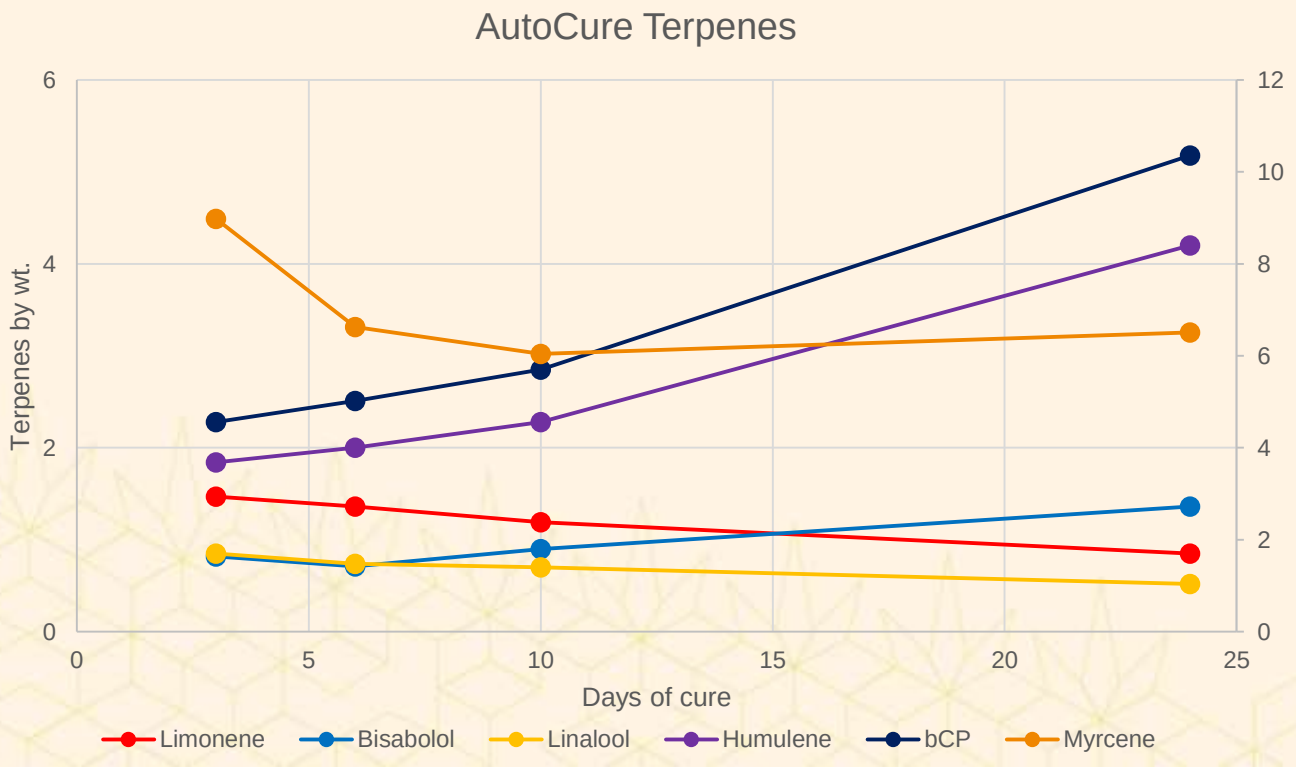


Terpenes during Cure



Terpenes during Cure

Maybe to individual terpenes?



Future Research

Spectrophotometry

- Sugars, chlorophyll, carotenoids
- pH changes

Is fermentation taking place?

- Lactic acid

What do humidity manipulation packs actually do?

Other additives for curing, e.g. oak wood.

Future Research

Cultivation techniques to enhance post-harvest quality

- Flushing

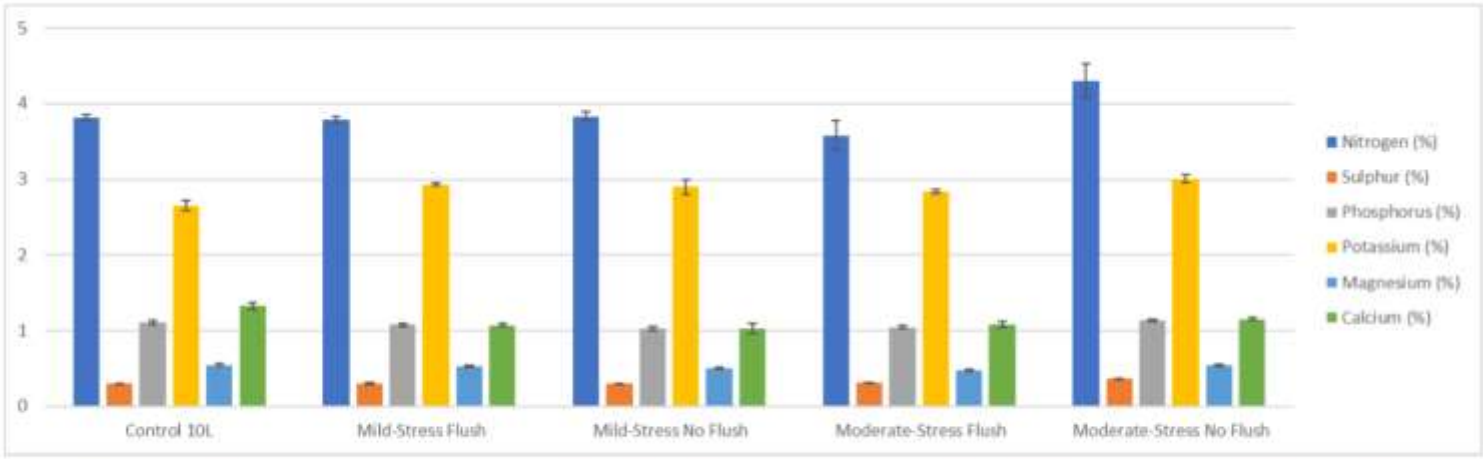


Figure 4.16 – Flower cycle 1 elemental analysis of bud after flushing. Shows the percent concentration by mass of the nutrients within the dried bud. Error bars represent the standard error (+/- SE). There are no significant differences between any of the treatments analyzed using ANOVA at significance of p<0.05.

- No significant differences!! BUT that does not mean other beneficial enzymatic processes are not set in motion.

Irrigation Management Strategies for Medical Cannabis in Controlled Environments.

Thesis completed at The University of Guelph. Jonathan Stemeroff.

Thanks

Legacy US

Nate Controls

AutoCure

Henkelman Vacuum Systems

outco

See expanded results from our experiments on IG:

@outcosd & @dr.justice_grows

And our blog:

http://outco.com/blog/

Thank You!