CRC
CANNABIS
RESEARCH COALITION

Research Report

JULY 2025

RESEARCH PROPOSAL

CALYX CONTAINERS

A post-harvest optimization study.

Abstract

Cannabis is a plant with numerous medicinal and recreational uses, but its full potential can only be realized with proper post-harvest treatment. The first step (drying) involves removing water from the plant for preservation and to prevent spoilage. The second, and less understood step, is curing. Curing cannabis involves slowly drying and aging the harvested flowers in a controlled environment to enhance quality. While limited research has been conducted on curing, anecdotal evidence and industry experience suggest that curing improves the flavor, aroma, and smoothness of the final product.

To better understand the curing process, it is essential to establish a baseline of key measurements beginning in the drying stage.

Materials and Methods

Drying & Curing Environment

SETPOINTS: 60F/60RH

Strain

“PEACHES & CREAM”

Experiment 1:
Bulk Container Holding

Bucking → Project Completion

8 Weeks of Curing

Collected Data: Expt. 1

CANNABINOIDS (DEGRADATION)
TERPENES
SOLUBLE SUGARS
CHLOROPHYLLS A & B
WEIGHT
WATER ACTIVITY
MOISTURE CONTENT
TRICHOME PIXEL ANALYSIS

Water Activity

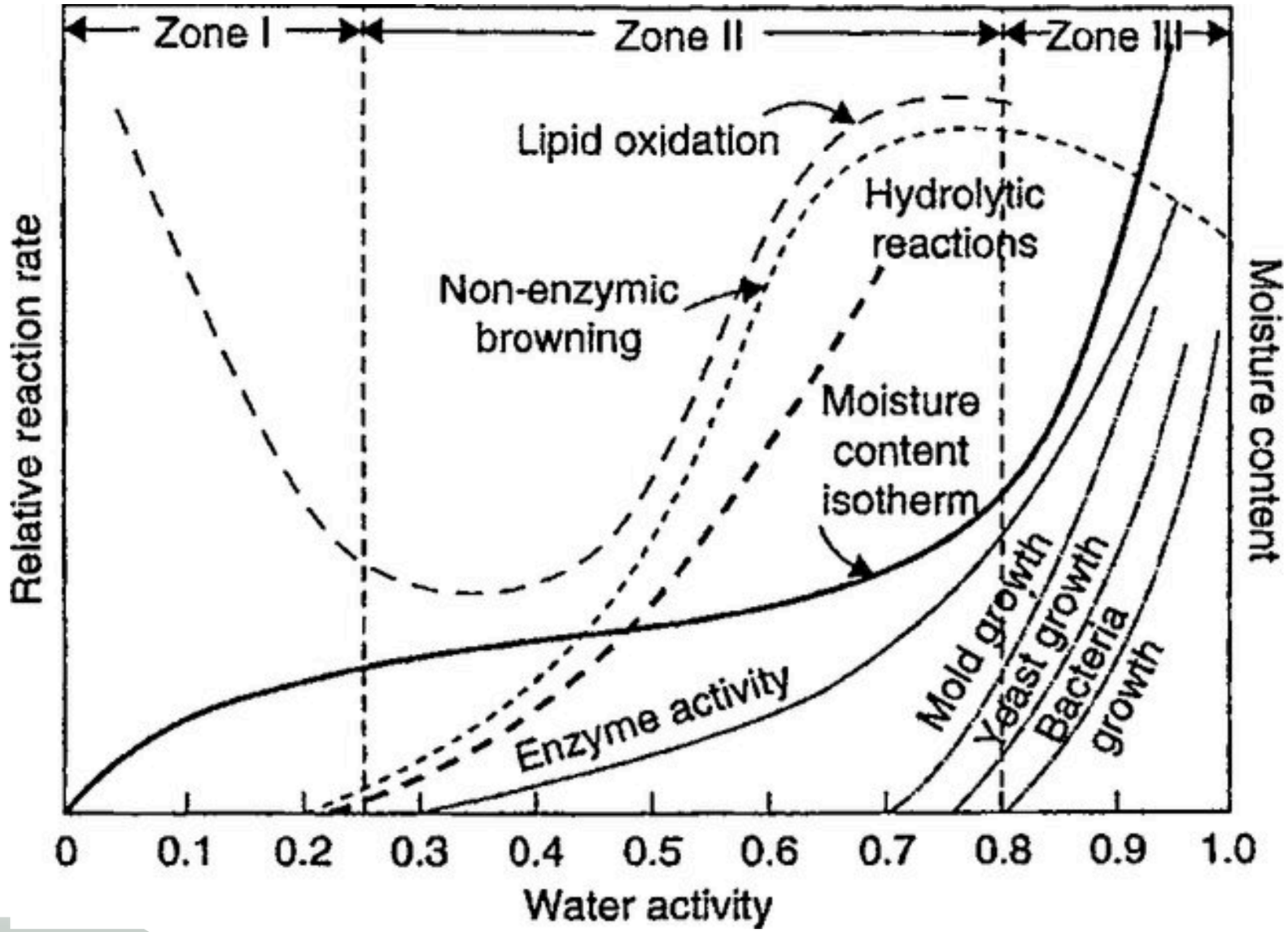
When we think of water activity we think of a limit we need to get beneath or microbial impact.

BUT

Enzymes need available water, not just water content. Enzymatic reactions occur efficiently only within a certain aw range.

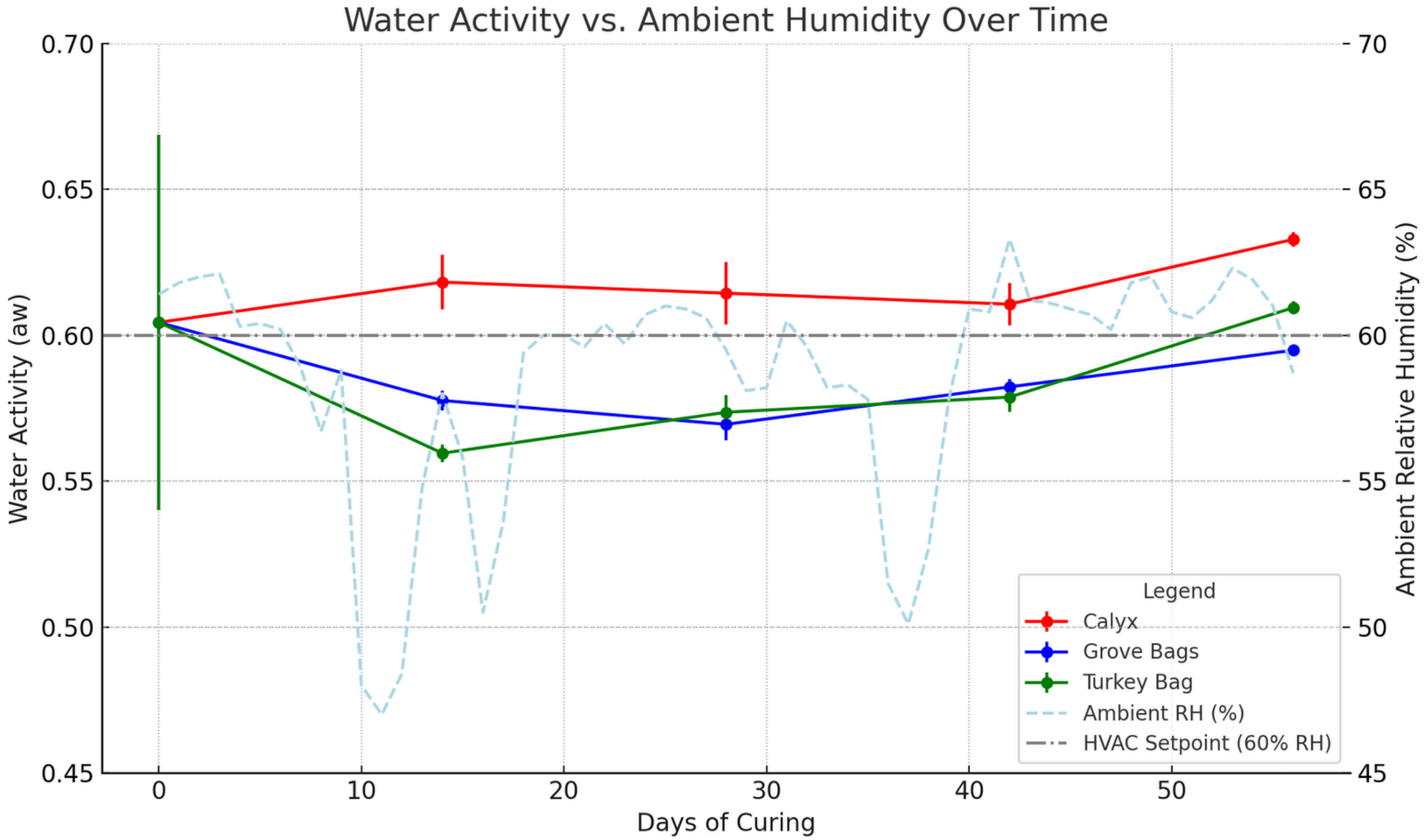
- Most plant and microbial enzymes require aw > 0.6 to remain active.
- Some specialized enzymes can function down to ~0.3–0.5, but with greatly reduced activity.

Stability Diagram



KESTER AND FENNEMA 1986, KROCHTA 2006

Water Activity



Water Activity

THE CURING ENVIRONMENT WAS MAINTAINED WITH AN ACTIVE DEHUMIDIFICATION AND HVAC SYSTEM (MINI SPLIT), PROGRAMMED TO HOLD A RELATIVE HUMIDITY (RH) SETPOINT OF 60%. THIS IS A TRADITIONAL SET UP IN TEH CANNABIS INDUSTRY. WHILE THE SYSTEM WORKED TO REMOVE MOISTURE, NO ACTIVE HUMIDIFICATION IS AVAILABLE, LEAVING ROOM CONDITIONS LARGELY INFLUENCED BY THE HUMIDITY OUTSIDE OF THE ROOM.

WHEN COMPARING THE BEHAVIOR OF THE DIFFERENT CONTAINERS:

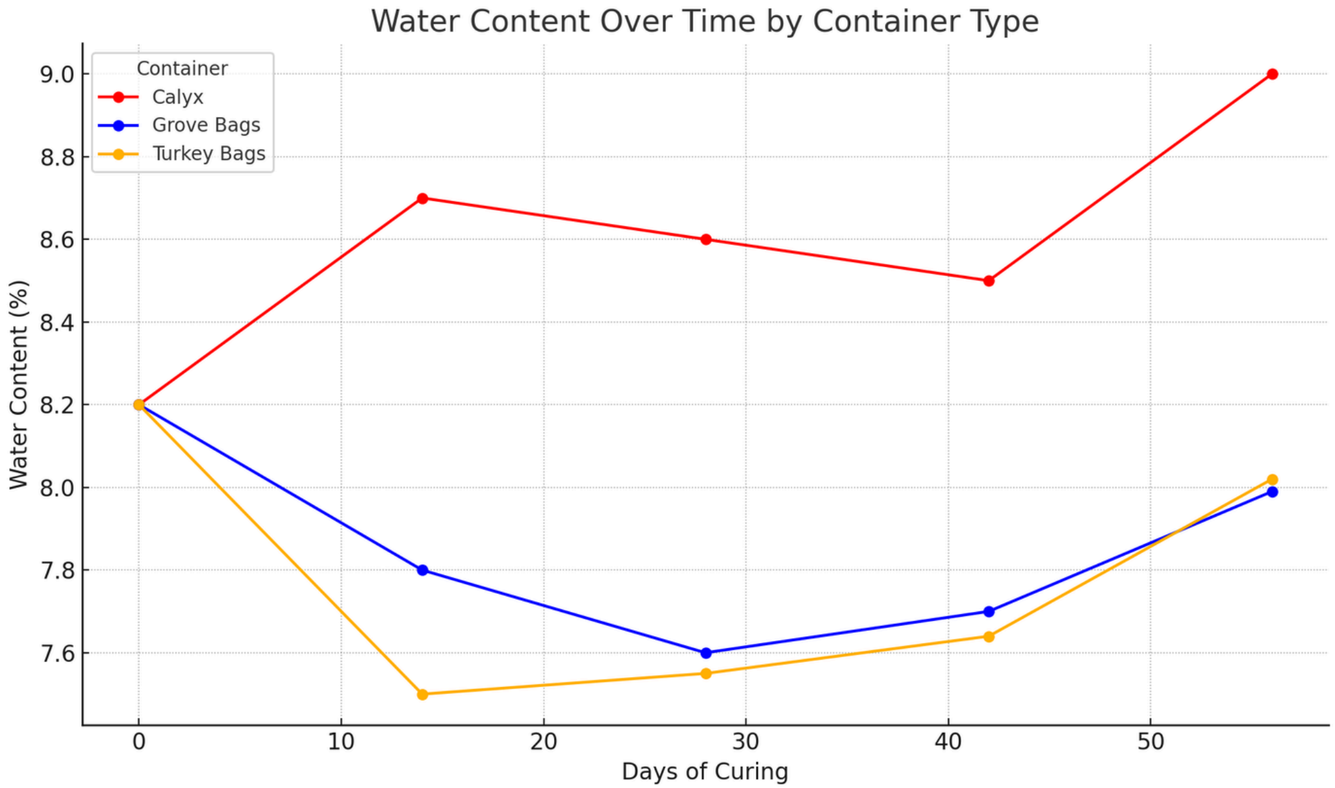
CALYX CONTAINERS CONSISTENTLY EXHIBITED WATER ACTIVITY (AW) ABOVE THE ROOM'S RH SETPOINT, SUGGESTING THE CONTAINER IS ABLE TO RETAIN OR EVEN ABSORB MOISTURE WITHOUT LOSING EVEN WHEN THE AMBIENT CONDITION CAUSE OTHER MATERIALS TO LOOSE MOISTURE.

TURKEY BAGS TENDED TO TRACK MORE CLOSELY WITH AMBIENT RH, SHOWING RELATIVELY LOWER AND LESS STABLE AW. THIS SUGGESTS THEY ALLOW MORE PASSIVE MOISTURE EXCHANGE WITH THE CURING ROOM, LIKELY DUE TO THEIR THINNER, LESS SPECIALIZED MATERIAL.

GROVE BAGS DISPLAYED AN INTERMEDIATE PROFILE TRACKING CLOSELY TO THE BEHAVIOR OF THE TURKEY BAG.

THESE RESULTS UNDERSCORE THE IMPORTANCE OF MATCHING CONTAINER PROPERTIES TO ROOM ENVIRONMENTAL CONTROL. IN CURING ROOMS THAT RELY ON DEHUMIDIFICATION ALONE (WITHOUT ACTIVE HUMIDITY ADDITION) CALYX PACKAGING, MAY HELP PRESERVE PRODUCT WEIGHT, CONSISTENCY, AND QUALITY. IN CONTRAST, MORE PERMEABLE CONTAINERS MAY RISK OVER-DRYING IF AMBIENT RH DROPS BELOW IDEAL CURING THRESHOLDS.

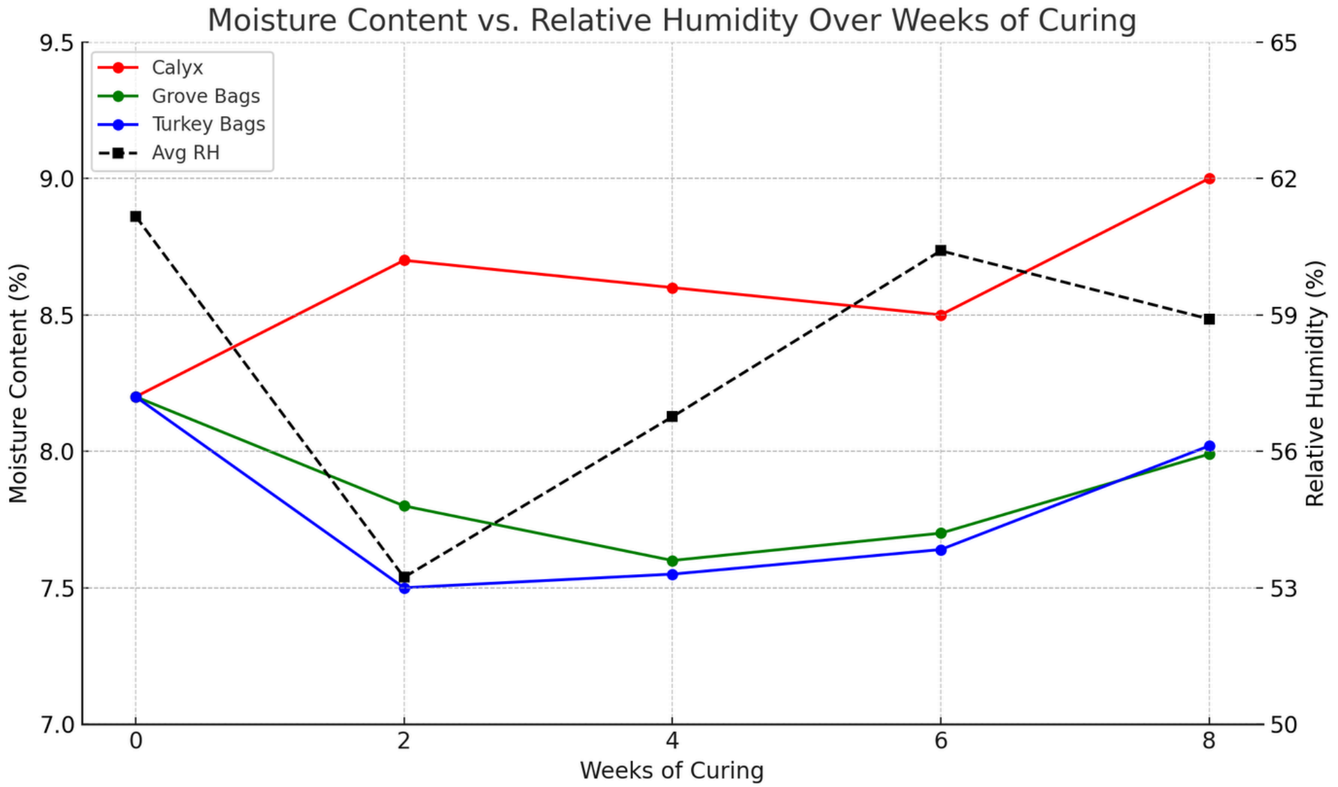
Moisture Content



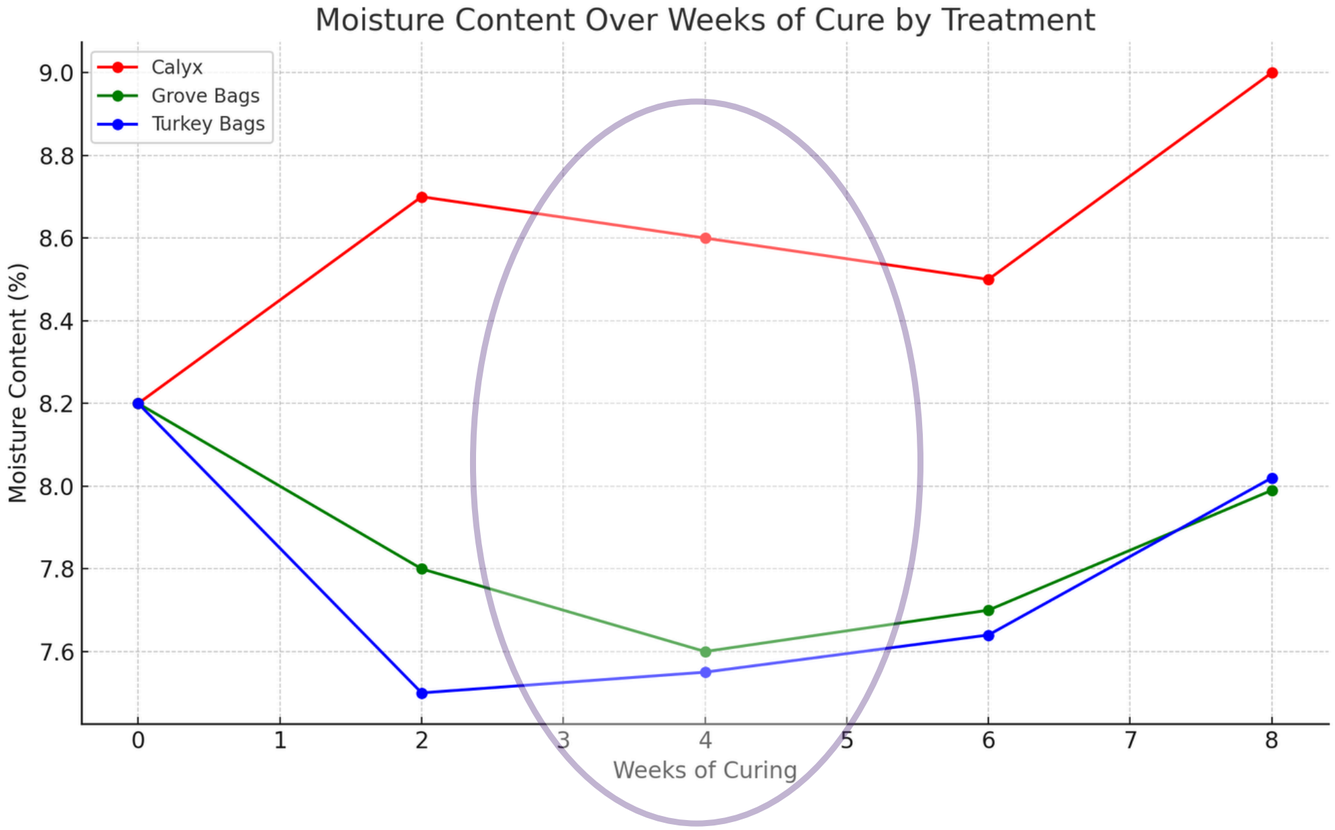
CALYX TRENDS UPWARD, SUGGESTING MOISTURE RETENTION AND REABSORPTION.

GROVE BAGS AND TURKEY BAGS BOTH SHOW SLIGHT DECREASES OR STABLE VALUES, WITH TURKEY BAGS STARTING LOWEST AND INCREASING BY DAY 56.

Moisture Content



Moisture Dynamics



AT DAY 28, ALL FLOWER MATERIAL WAS REMOVED FROM CURING CONTAINERS FOR PROCESSING. EACH TREATMENT BEGAN WITH 100 POUNDS (45,359.2 GRAMS) OF CANNABIS FLOWER. MOISTURE CHANGE CALCULATIONS AT THIS POINT HIGHLIGHT SIGNIFICANT DIFFERENCES IN CONTAINER PERFORMANCE:

CALYX= GAIN OF 362.87 GRAMS
GROVE BAGS= LOSS OF 272.2 GRAMS
TURKEY BAGS= LOSS OF 294.8 GRAMS

IF WE CONSIDER 1G= $5, THEN

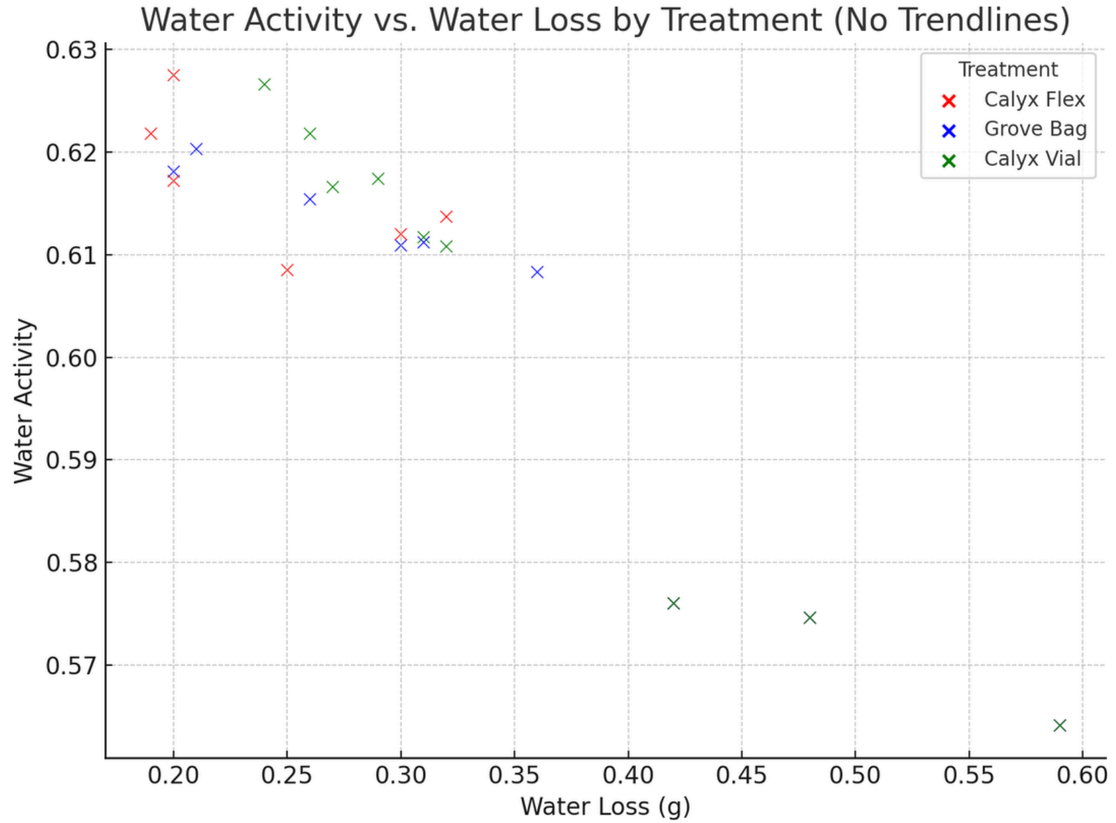
CALYX: $907.18 GAIN

GROVE BAGS: $1,360.78 LOSS

TURKEY BAGS: $1,474.17 LOSS

Stats 101: Trendlines

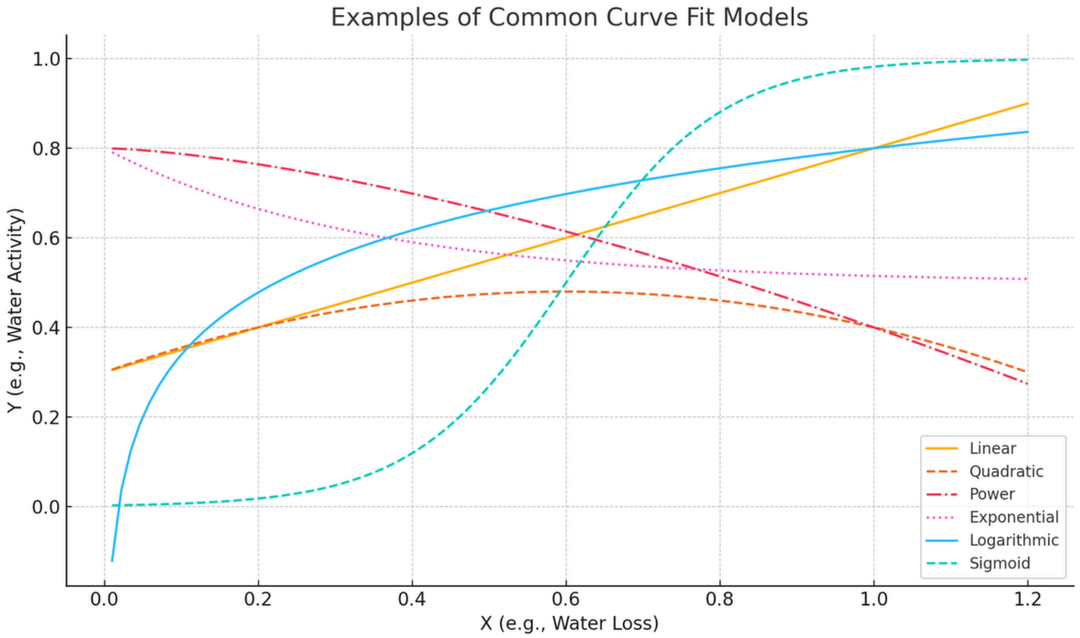
IF WE WANT TO COMPARE TWO SETS OF DATA (EXAMPLE: WATER ACTIVITY AND MOISTURE CONTENT) WE END UP WITH A GRAPH WITH A BUNCH OF DOTS LIKE THIS...



HOW DO WE MAKE SENSE OF THE MADNESS?

Stats 101: Trendlines

THERE ARE DIFFERENT STATISTICAL MODELS TO TRY!



- WHEN WE LOOK AT DATA, WE START BY NOTICING THE SHAPE OF THE POINTS ON A GRAPH. THIS GIVES US CLUES ABOUT WHAT KIND OF MODEL TO TRY:

- STRAIGHT-ISH LINE? → TRY A LINEAR MODEL
- CURVES UPWARD OR DOWNWARD? → TRY A QUADRATIC OR POWER MODEL
- STARTS STEEP, THEN LEVELS OFF? → TRY AN EXPONENTIAL OR LOGARITHMIC MODEL
- S-SHAPED (SLOW → STEEP → FLAT)? → TRY A SIGMOID MODEL

ONCE WE PICK A FEW POSSIBLE MODELS, WE DO SOME MATH TO FIND THE ONE THAT BEST DRAWS A CURVE THROUGH THE DOTS. THAT MATH GIVES US A VERY IMPORTANT SCORE CALLED R^2 (PRONOUNCED "R-SQUARED").

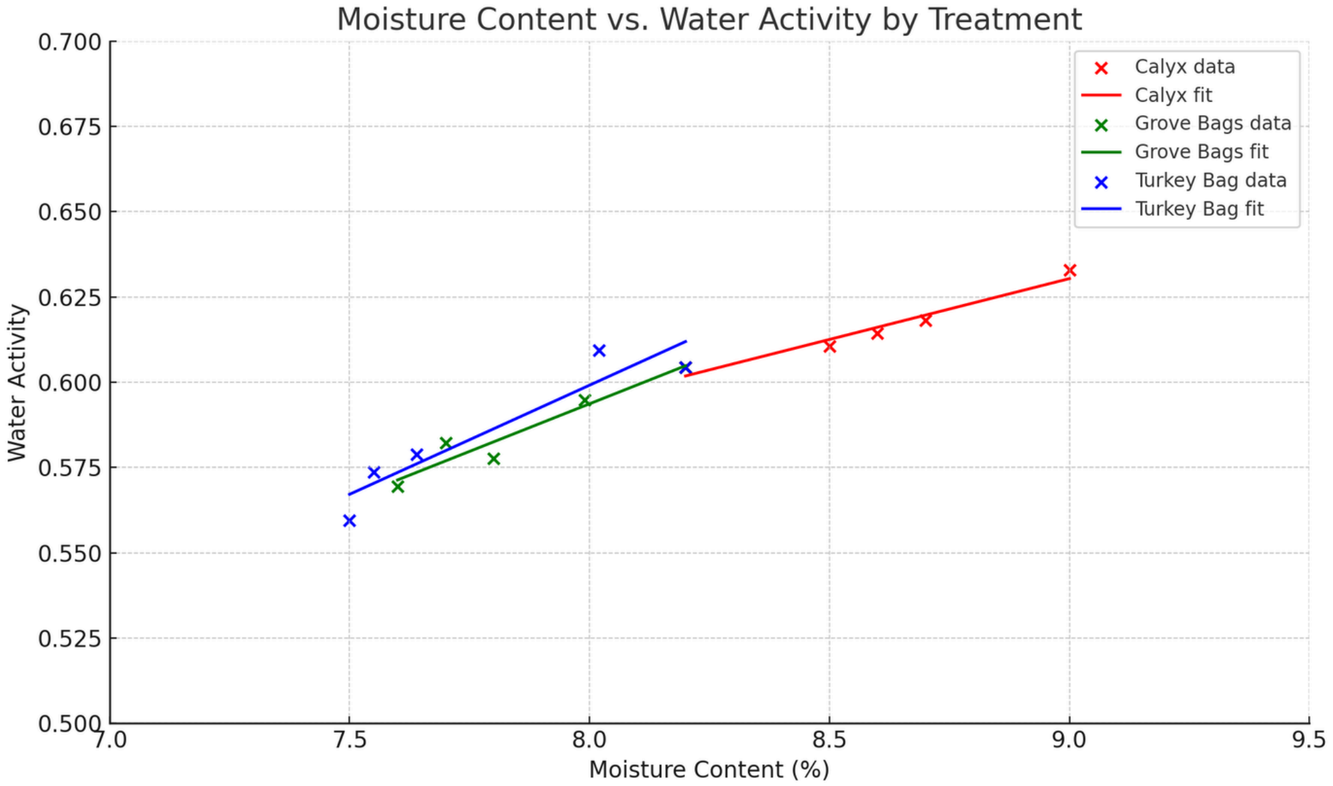
WHAT'S R^2?

- R^2 TELLS US HOW WELL THE MODEL FITS OUR DATA. IT'S A NUMBER BETWEEN 0 AND 1:
- $R^2 = 1$ → A PERFECT FIT: EVERY POINT FALLS RIGHT ON THE LINE
- $R^2 = 0.9+$ → A VERY STRONG FIT
- $R^2 = 0.5$ → THE MODEL KIND OF WORKS
- $R^2 = 0$ → THE MODEL DOESN'T EXPLAIN THE DATA AT ALL

WE USE R^2 TO COMPARE MODELS AND DECIDE WHICH ONE TELLS THE CLEAREST, MOST USEFUL STORY ABOUT THE DATA.

IN SHORT: A BETTER R^2 = A BETTER MODEL = MORE CONFIDENCE IN YOUR CONCLUSIONS.

Moisture Dynamics

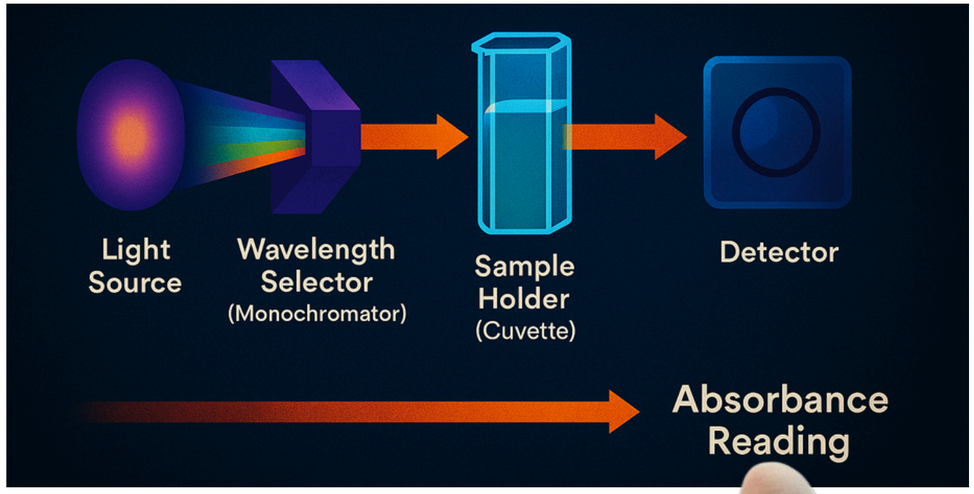


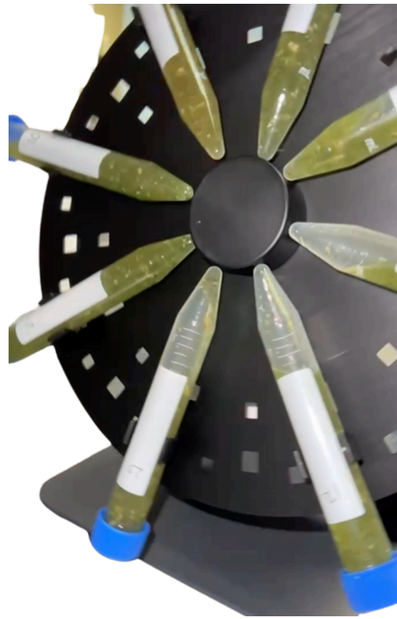
ACROSS ALL CURING TREATMENTS, MOISTURE CONTENT AND WATER ACTIVITY SHOWED A STRONG, STATISTICALLY SIGNIFICANT LINEAR RELATIONSHIP, WITH PEARSON CORRELATION COEFFICIENTS OF 0.976 FOR CALYX, 0.961 FOR GROVE BAGS, AND 0.939 FOR TURKEY BAG.

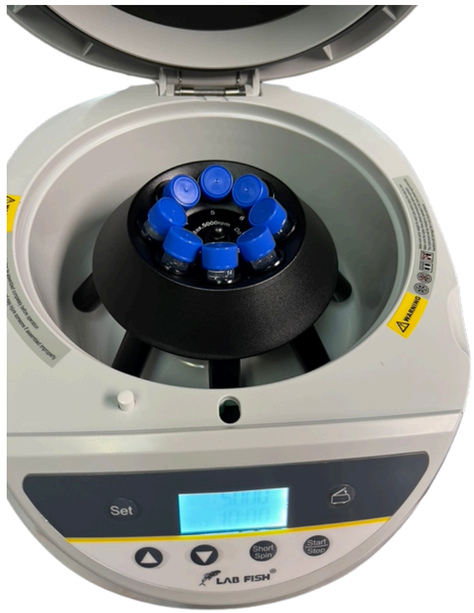
LINEAR REGRESSION ANALYSIS REVEALED THAT AS MOISTURE CONTENT INCREASED, WATER ACTIVITY ROSE PROPORTIONALLY WITHIN EACH TREATMENT, WITH THE TIGHTEST AND MOST CONSISTENT RELATIONSHIP OBSERVED IN THE CALYX PACKAGING. THIS SUGGESTS THAT CALYX PROVIDES THE MOST STABLE INTERNAL ENVIRONMENT, ALLOWING FOR RELIABLE PREDICTION OF WATER ACTIVITY FROM SIMPLE MOISTURE MEASUREMENTS. WHILE ALL TREATMENTS FOLLOWED THE SAME GENERAL TREND, THE SLIGHTLY WEAKER CORRELATION IN TURKEY BAGS MAY INDICATE GREATER VARIABILITY IN MOISTURE BUFFERING OR PERMEABILITY.

OVERALL, THE STRONG STATISTICAL ALIGNMENT SUPPORTS THE USE OF MOISTURE CONTENT AS A PROXY FOR WATER ACTIVITY DURING CANNABIS CURING, ESPECIALLY WHEN VALIDATED PER PACKAGING TYPE.

Spectrophotometer



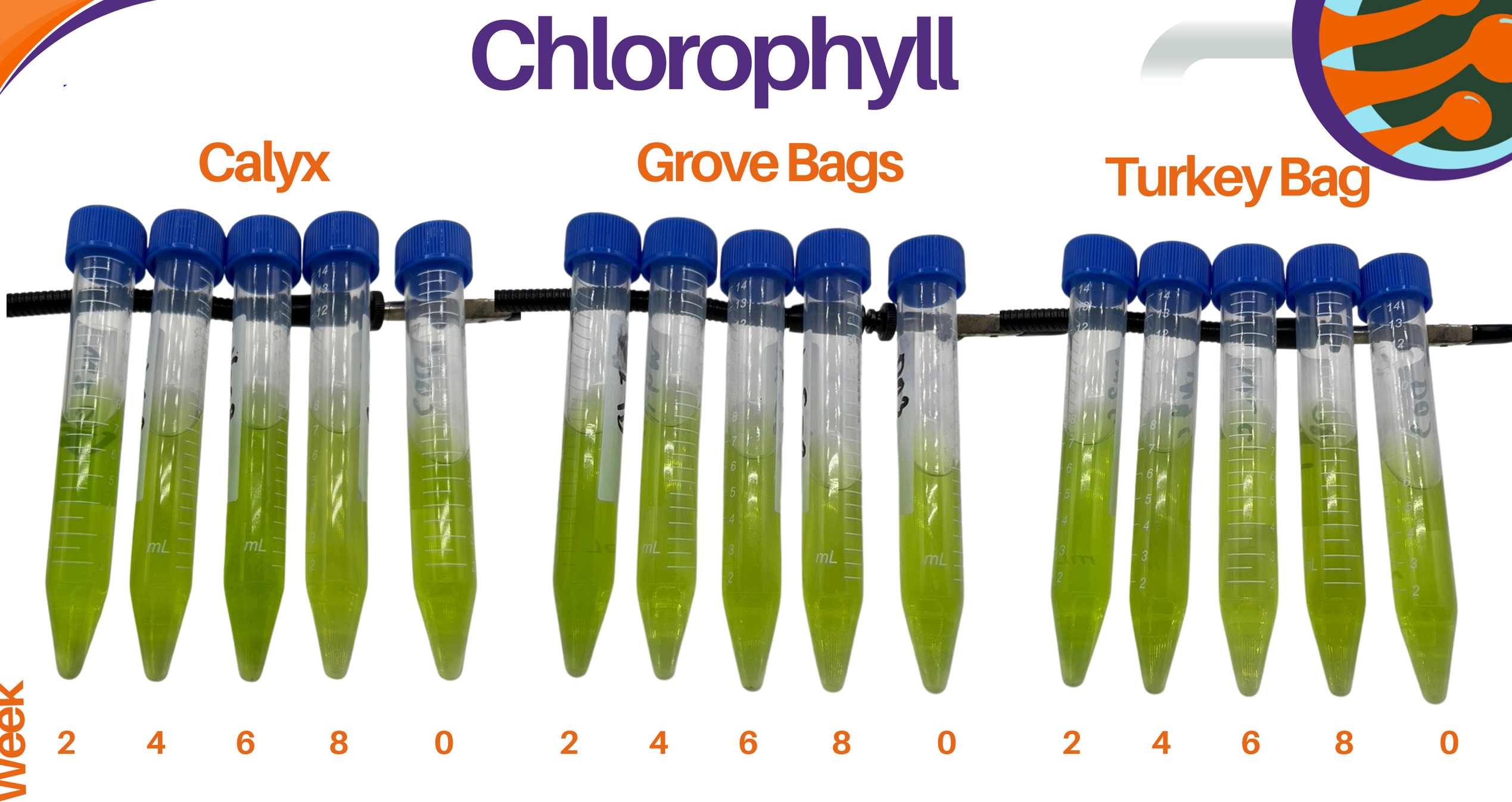




Measured Wavelengths

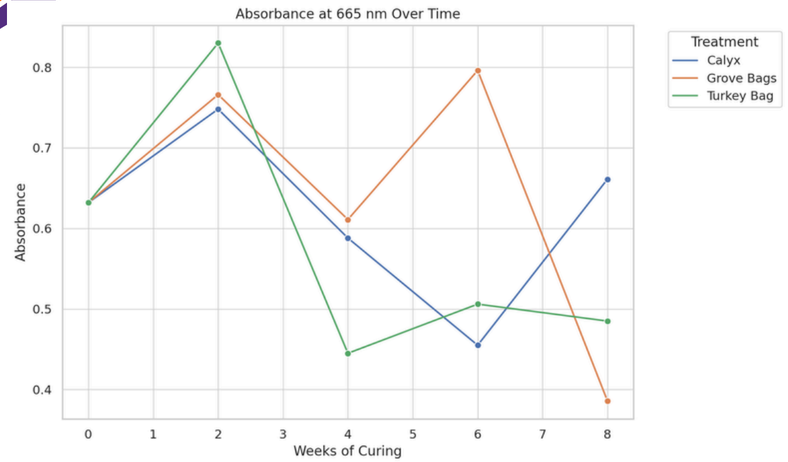
Wavelength (nm)	Target Compounds or Signal	Interpretation
470	Carotenoids	Pigment degradation, light-sensitive antioxidant loss
649	Chlorophyll b	Breakdown of chlorophyll and green pigments
665	Chlorophyll a	Loss of photosynthetic capacity and green coloration

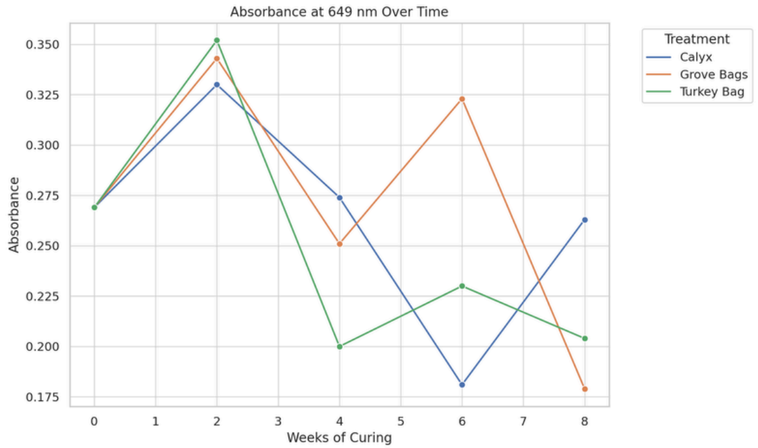
Chlorophyll

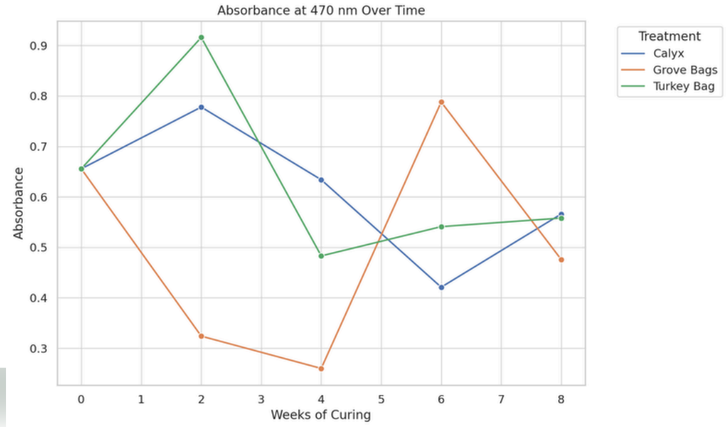


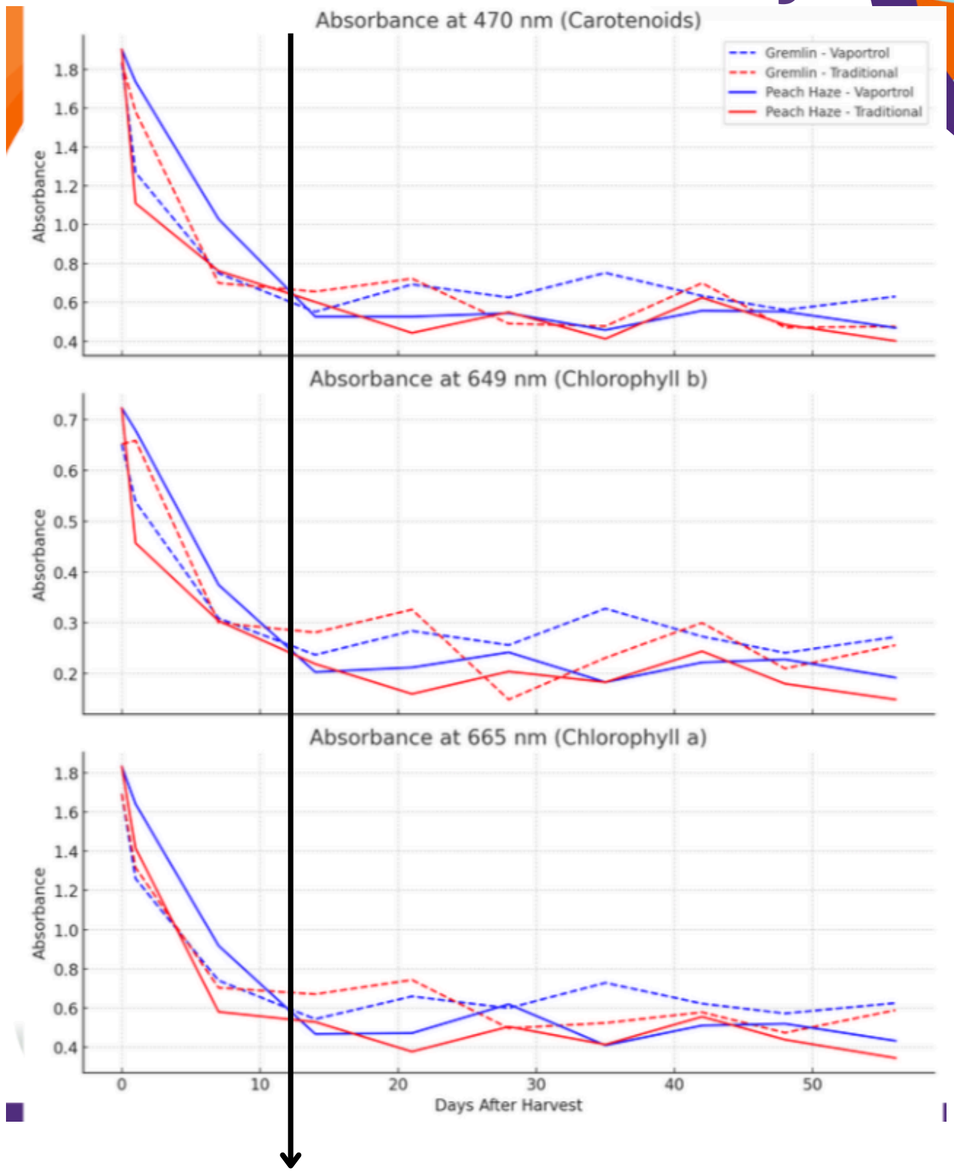
Pigments

Cannatrol Study









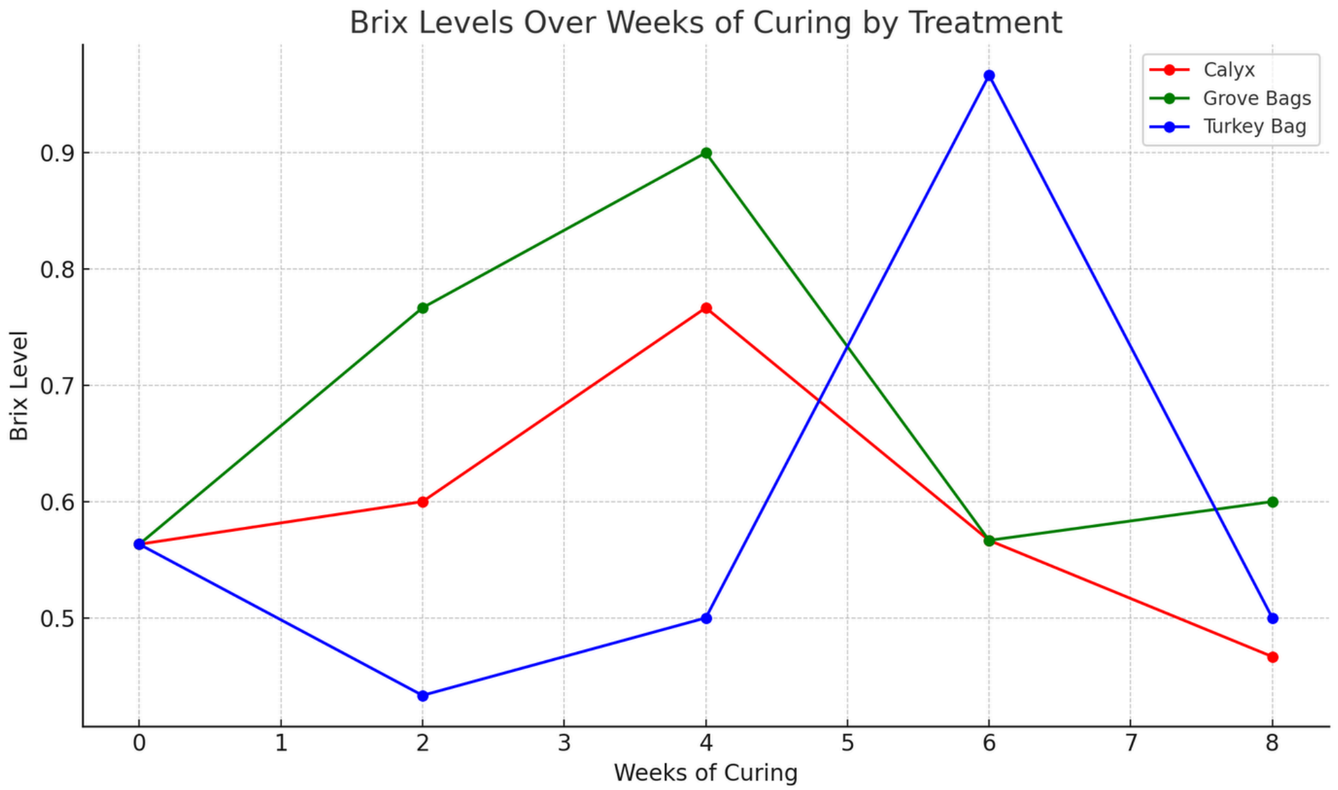
Brix- Soluble Sugars

BRIX (REFRACTOMETER) IS A MEASURE OF THE SUGAR CONTENT IN AN AQUEOUS SOLUTION, COMMONLY USED TO GAUGE THE SWEETNESS OF PLANT SAP, FRUIT JUICES, OR OTHER LIQUIDS EXPRESSED IN DEGREES BRIX (°BX).

BRIX DOES NOT DIRECTLY ACCOUNT FOR STARCH. BRIX MEASURES SOLUBLE SOLIDS IN A SOLUTION, PRIMARILY SUGARS LIKE SUCROSE, GLUCOSE, AND FRUCTOSE, ALONG WITH OTHER DISSOLVED COMPOUNDS LIKE ORGANIC ACIDS.

STARCH IS NOT SOLUBLE IN WATER UNDER NORMAL CONDITIONS AND DOES NOT DISSOLVE TO CONTRIBUTE TO THE BRIX MEASUREMENT.

Brix- Soluble Sugars



SENESCENCE (NATURAL AGING) SIGNALS TRIGGER CELLULAR AUTOLYSIS= THE BREAKDOWN OF STORED RESERVES.

THE PLANT MOBILIZES STARCH TO SIMPLE SUGARS FOR USE IN:

FINAL BURSTS OF RESPIRATION

PIGMENT BREAKDOWN

SECONDARY METABOLITE SYNTHESIS

ONCE SUGARS ARE FORMED, THEY:

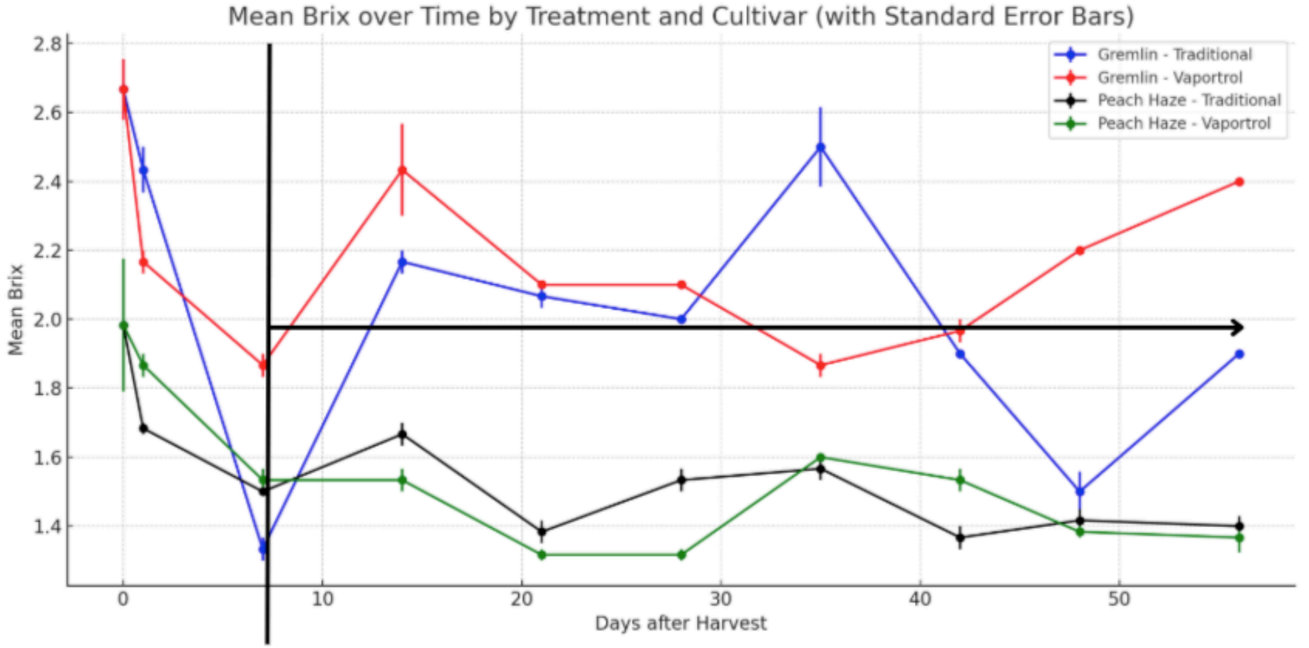
FUEL MAILLARD-TYPE REACTIONS → CREATE BROWNING PIGMENTS (A420)

CAN VOLATILIZE OR OXIDIZE INTO ALDEHYDES AND ESTERS → CONTRIBUTE TO SWEET, NUTTY, OR MALTY AROMAS

MAY ALSO FEED MICROBIAL FERMENTATION UNDER CERTAIN CURING CONDITIONS

Brix

In a recent study with Cannatrol, we noticed the same erratic trends after plant material dropped down below a 0.7 aw.



If Brix decreases → Sugars are likely being metabolized.

Respiration: sugars used as energy.

Maillard or PPO reactions: sugars + amino acids → browning compounds

Secondary Metabolites

Decarboxylation

Starting Decarboxylation (%)	2.90%
Calyx (after 8 weeks of cure)	14.80%
Grove Bags (after 8 weeks of cure)	13.10%
Turkey Bag (after 8 weeks of cure)	13.90%

Terpenes

<u>In general:</u>

Monoterpenes drop the most!

Limonene (−11% Calyx, −33% Grove) and β-myrcene (−21% Calyx, −37% Grove) fall hard. They're the most volatile, so evaporation + sorption into packaging films is the usual culprit.

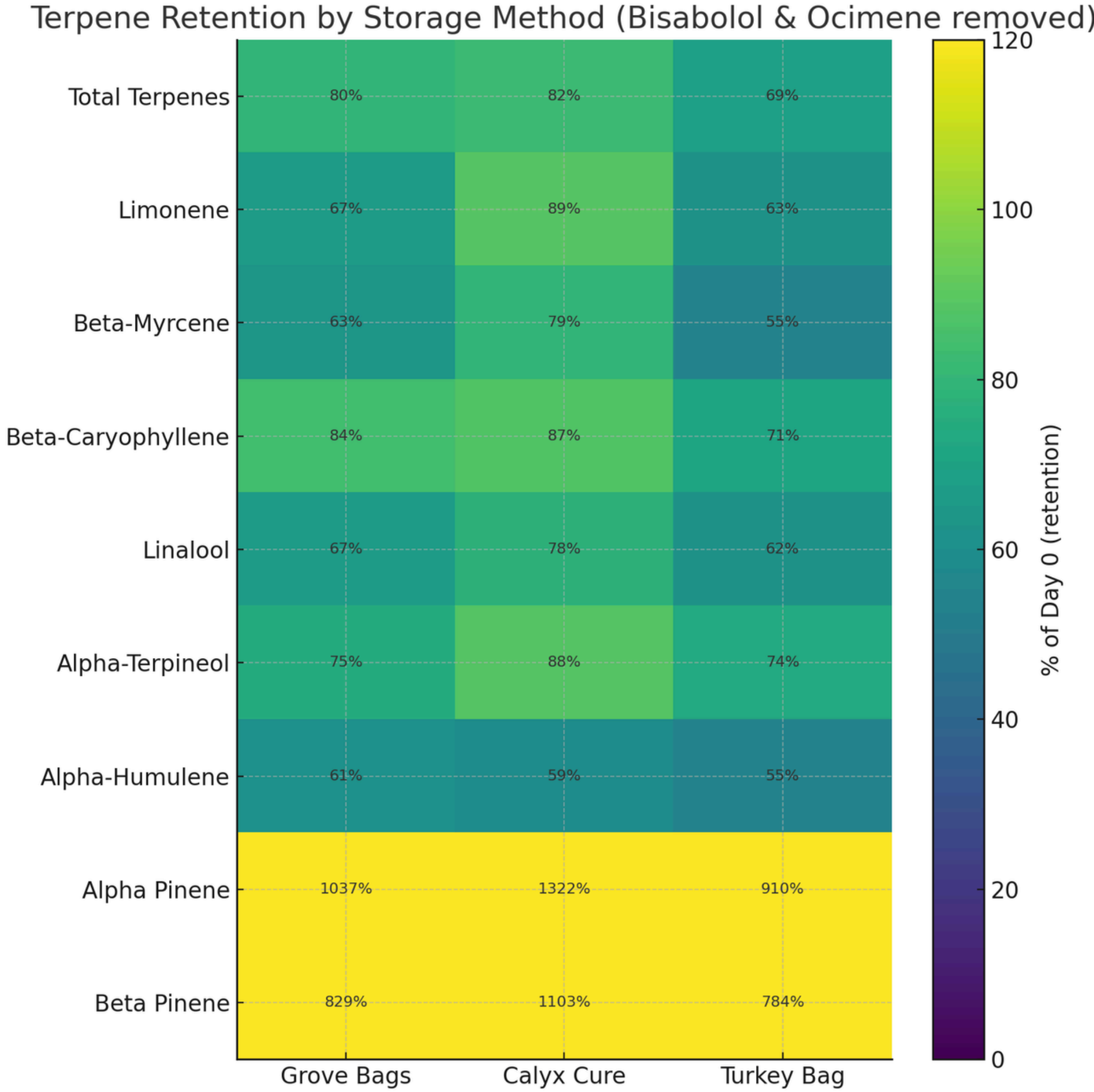
Some monoterpenes rise a lot.
Possible isomerization/rearrangement of other monoterpenes.

Sesquiterpenes generally decline.

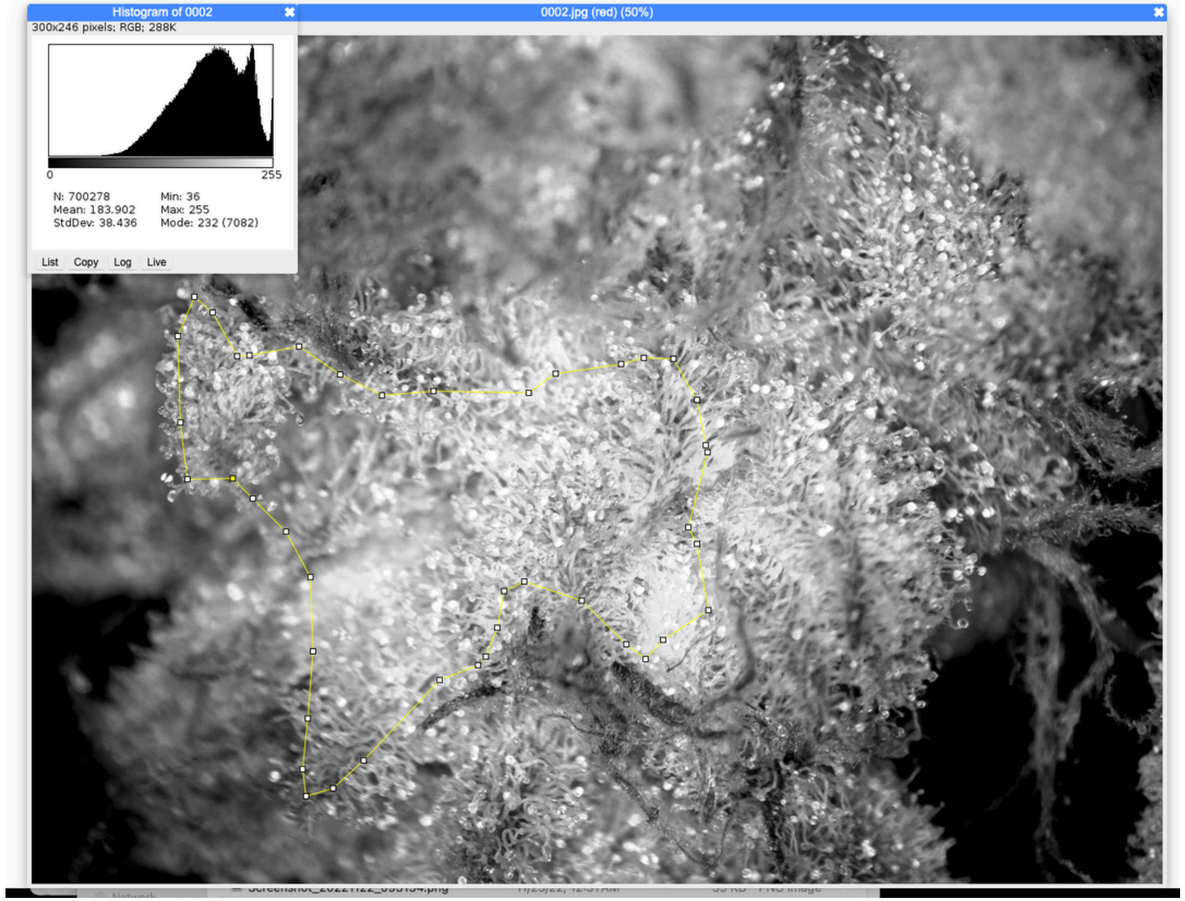
<u>Treatments:</u>

Calyx retains more monoterpenes (limonene −11% vs −33% Grove Bags), suggesting lower oxygen/ vapor transmission rates or better sealing.

Grove/Turkey show the biggest losses meaning potentially higher permeability or more headspace allowing vapor-phase loss.



Amber Trichome Formation



LIGHT IMAGING SOFTWARE WILL BE UTILIZED TO QUANTIFY COLOR CHANGE IN THE GLANDULAR TRICHOME HEAD.

PRIOR PEER REVIEWED STUDIES SUPPORT THIS PROTOCOL FOR ANALYSIS OF TRICHOME MATURITY. TRICHOME EVALUATION WOULD OCCUR AT THE END OF THE EXPERIMENT WHERE FLOWER LOCATION (TOP CANOPY, LOWER CANOPY WITH AND WITHOUT BCL) WOULD BE THE FOCUS.

HTTPS://WWW.SCIENCEDIRECT.COM/SCIENCE/ARTICLE/PII/S2772375522000764#:~:TEXT=2.2.-,TRICHOME%20MATURATION,MATURATION%20%5B10%2C13%5D.

Secondary Metabolites

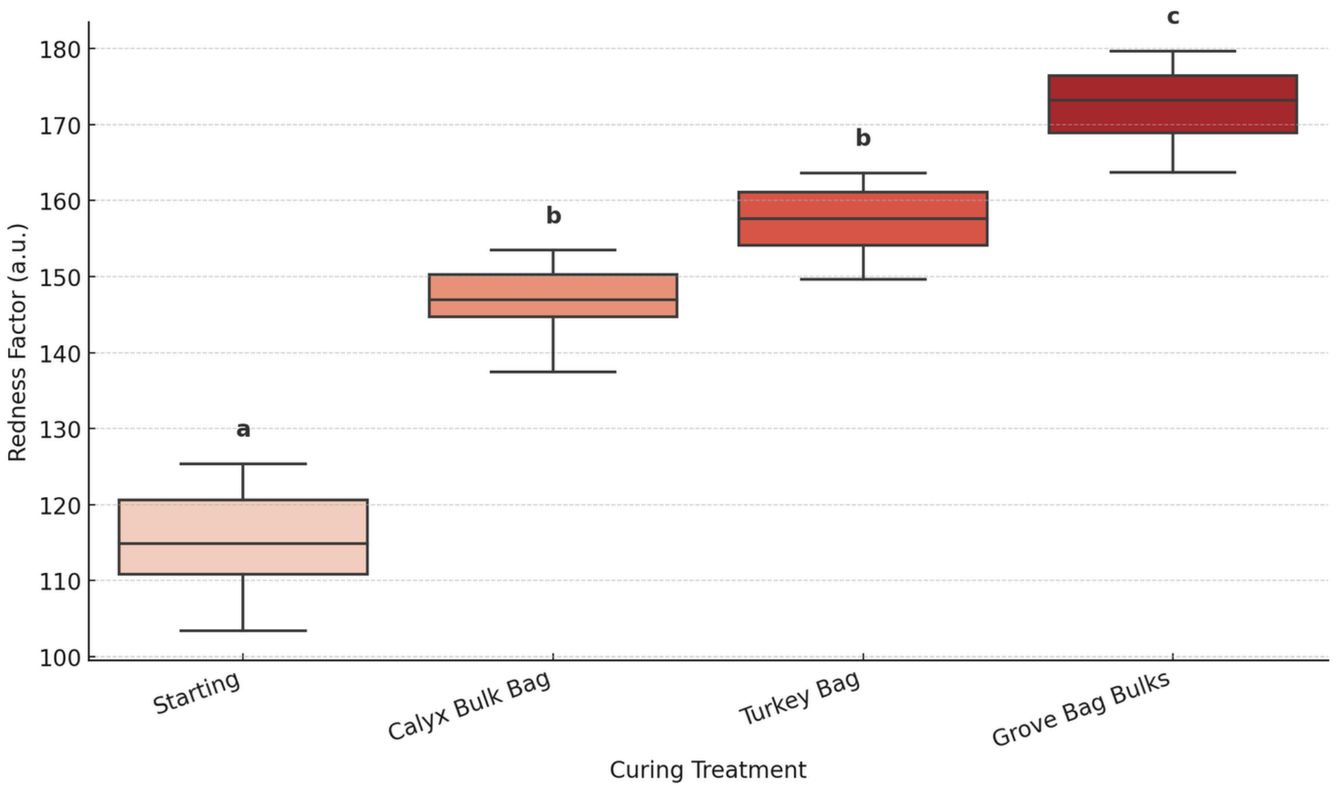


FIGURE. REDNESS FACTOR OF CANNABIS FLOWERS AFTER CURING IN DIFFERENT PACKAGING TREATMENTS. BOXPLOTS REPRESENT THE DISTRIBUTION OF REDNESS FACTOR VALUES (ARBITRARY UNITS) FOR EACH TREATMENT. TREATMENTS LABELED WITH DIFFERENT LETTERS ARE SIGNIFICANTLY DIFFERENT (TUKEY HSD, $P < 0.05$).