Sugar and Vinegar as Vase Solution Additives

Effects on the Vase Life of Cut Roses (Rosa hybrida)

Team 5

I. Scientific Question

Why roses and its vase life?

Importance of Vase Life

Vase Life : The Key Quality Indicator

→ Marketability

→ Consumer Satisfaction

→ Repurchase Rates

Necessity of Customized Research

Existing Guides: Limited to general information

Biological Reality: Traits vary by flower type

Need: Species-specific methods

Reason for Selecting Roses

Roses

: The most **accessible** and **frequently purchased**

Commonly used flower preservation methods

Research Subject: The most accessible and frequently purchased varieties

↓

Practical Value: **Easy-to-follow** preservation methods for ordinary households

Research Question

Which water treatment method most effectively extends the vase life of cut roses among tap, sugar, vinegar, and sugar-vinegar water?

II. Treatments & Response Variable

Why Sugar and Vinegar? & Termination Criteria

Substances used to extend Vase Life

Sucrose

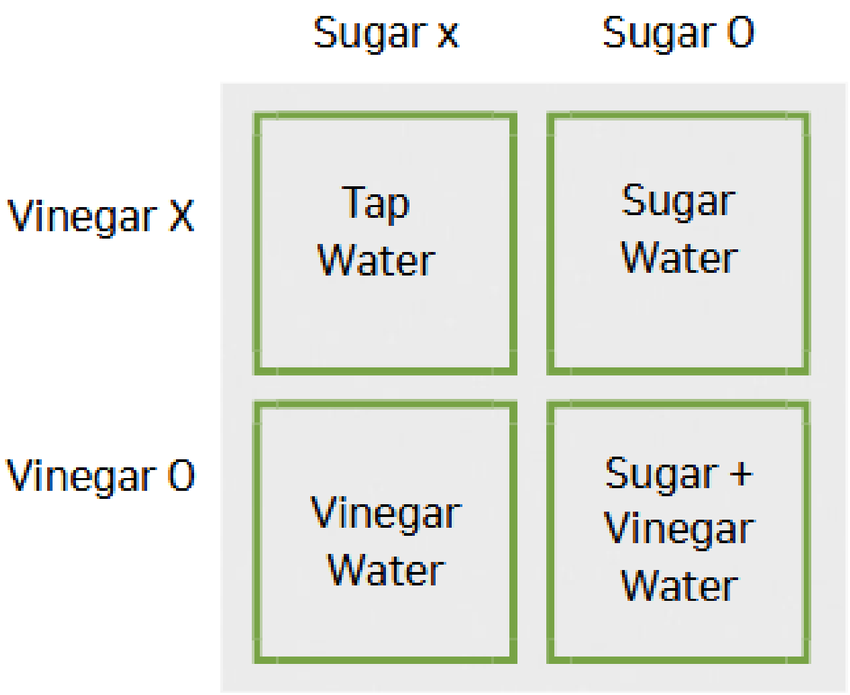
- Acts as respiratory substrates to delay aging
- Increases body weight
- Facilitate water absorption by raising osmotic pressure

Acidic substances

ex) Aluminum sulfate, HQC, HQS, ...

- Exert a bactericidal effect
- Facilitate water absorption by acidifying the preservative solution

→ Select White Sugar , White Vinegar



Tap Water

- serves as the control in this experiment

2% concentration Sugar Water

- 10 g of sugar is dissolved in tap water, and the final volume is adjusted to 500mL

0.6% concentration Vinegar Water

- 3 mL of white vinegar is added to tap water, and the final volume adjusted to 500 mL

2% concentration Sugar + 0.6% concentration Vinegar Water

- 10 g of sugar and 3 mL of white vinegar is added to tap water, and the final volume is adjusted to 500 mL.

-All solution is **left at room temperature for 30 minutes**
: To prevent the difference in water temperature between the beginning and the end

-Each vase holds **120mL** of each Trt

-The Sugar, Vinegar, Sugar+Vinegar's concentration is adopted
from **De Silva et al. (2013)**

-To minimize the risk of microbial contamination,
each treatment is **replaced at 48-hour intervals** throughout the experimental period.

Beksul White Sugar & OTOKI White Vinegar

Response Variable

- Response variable : Rose Freshness

- **Definition** : **Number of days** in the vase until termination
- **Criteria** : Based on the **VBN Rosa Evaluation Card**

Justification for Termination Criteria

VBN card

→ Target-Specific Standards

→ Institutional Authority

→ Global Reliability

6 criteria selected from the VBN card

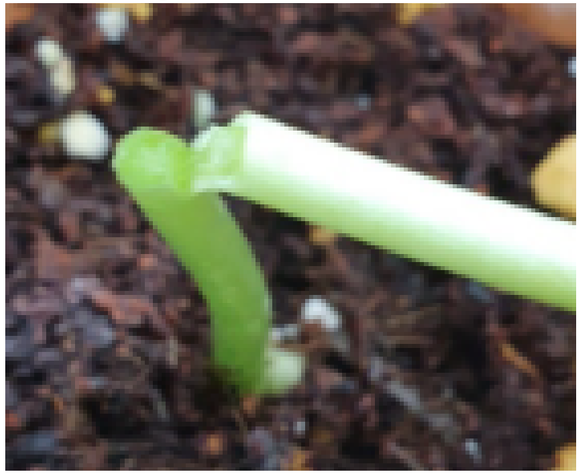
Bent neck

End of Flowering

Botrytis

Brown Flower

Kinking



Yellow and/or Brown Foilage

6 criteria selected from the VBN card

Plant Part	Criterion	Write-off
Flower-Related	Bent neck	Flower angle > 90°
	Brown Flower	> 50% of total petal surface area
	End of Flowering	> 2 petals fallen, or flower visibly limp (discoloration alone NOT sufficient)
Stem-Related	Kinking	Upon detection
	Botrytis	Upon detection
Foliage-Related	Yellow and/or Brown Foilage	> 50% of total leaf surface area or > 50% of total leaf count

Measurement Method

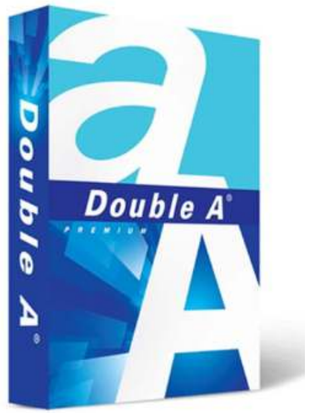
Observation time

- Observations are conducted twice daily at **08:00** and **20:00**

Photo mode settings

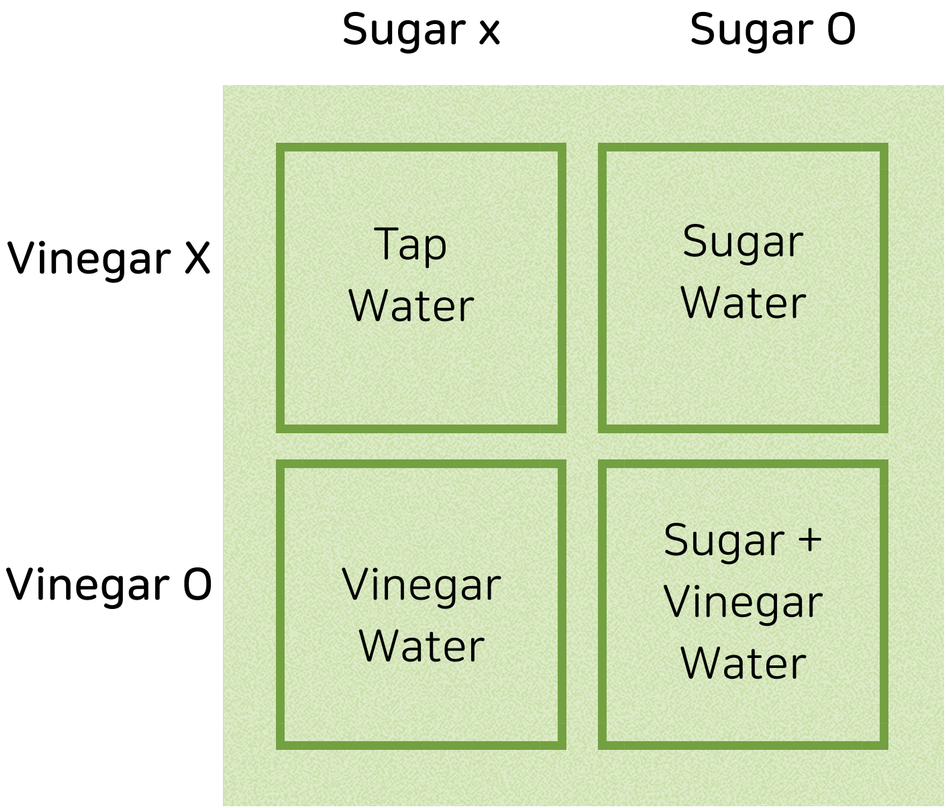
- ISO 50
- White balance 5500K
- Shutter speed 1/10s
- In-built software colour correction disabled

Double A white A4 paper



III. Treatment Assignment

Blocking & Randomisation



× 8 = 32

Total Replicated Experimental Units

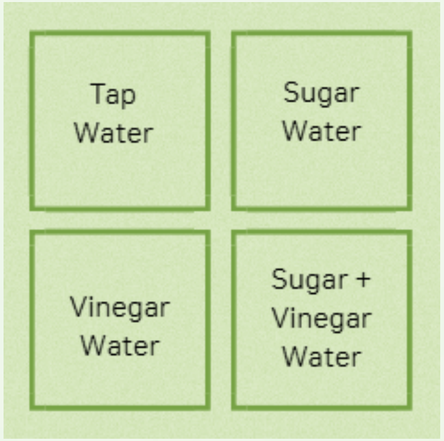
Experimental Design Structure

Blocking: **Location** was treated as a **Blocking Factor** (2 Blocks)

Design Details: Each location contained a **Complete and Balanced set of the factorial design**

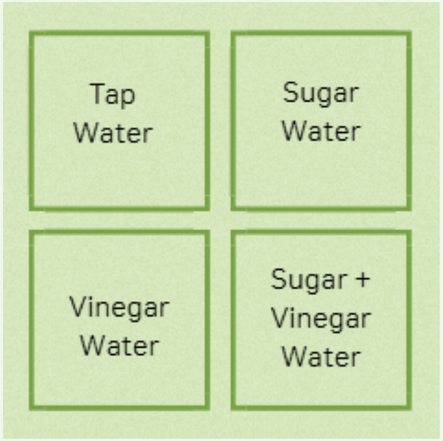
Replications: **4 replications of each** treatment combination within each block

Block 1



× 4 = 16 Units

Block 2



× 4 = 16 Units

Treatment Labelling

- Vase 1-4 : Tap water
- Vase 5-8 : 2% Sugar water
- Vase 9-12 : 0.6% White Vinegar water
- Vase 13-16 : 2% Sugar + 0.6% White Vinegar water

Vase Position Randomisation

- R using a fixed seed (set.seed(99))

Position	Vase	Position	Vase
1	16	9	8
2	1	10	14
3	12	11	11
4	6	12	4
5	13	13	7
6	5	14	10
7	3	15	9
8	2	16	15

IV. Nuisance Variation

Nuisance Sources and Strategies

Category of Nuisance	Specific Nuisance Source	Strategy
Plant Material Variability	Initial Stem Length Variability	recut to a length of 18–20 cm
	Individual Stem Variability	assigned to treatments without selection based on individual characteristics
Environmental and Spatial Variability	Temperature, Humidity, and Microbial Contamination	Monitoring temperature and humidity & renewing the solution every 48 hours
	Location	Location Blocking
	Light Exposure Within Location	Block out natural light by drawing the curtains
	Type of Vase	Using the same vase model (Daiso, item no. 1052134)
Measurement and Observation Variability	Observer Subjectivity	Using VBN, imageJ
	Camera Positioning and Settings	Images were taken from directly above whenever possible & Unify camera settings

V. Independence & Confounding

Nuisance Sources and Strategies

Independence

Roses were

-Physically separated

-Received individual solution allocations

-Measured independently

Potential Confounds & Resolution

Controlling Location and Observer Bias (Blocking Design)

Design
: Designate each location as a single **Block**

Ensuring Independence Between Factors (2 × 2 Full Factorial Design)

Design
: Experiment with all four possible combinations of
sugar (with/without)
×
vinegar (with/without)

Procedural Consistency

Design
: Apply the same '48-hour solution replacement cycle' to all groups

VI. Ethics and Safety

Is the experiment safe and ethical?

Ethics and Safety

Participants

-Involved **only the two team members**

-No external participants

Material Safety

Involved only

- Cut Roses
- Tap Water
- Sugar
- Diluted vinegar

Ordinary Care

-No additional ethics or safety measures were required

VII. Execution

Initial Plan and Actual Execution

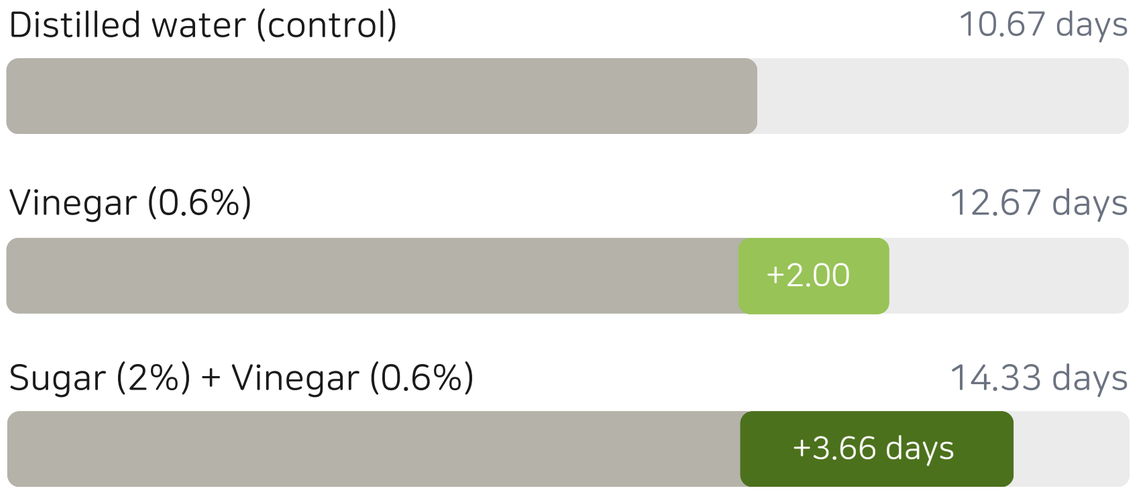
Planned	Actual	Reason
23–25°C	25–28°C	Ambient temperature fluctuations
100mL per vase	120mL per vase	To ensure the rose stem is sufficiently submerged in water
Vase placed at the center of a full A4 sheet	Vase placed at the center of an A4 sheet cut in half	Insufficient experimental space

Planned	Actual	Reason
7 termination criteria selected from the VBN Rosa Evaluation Card	Exclude Leaf Shedding (Abscission)	The initial number of leaves for each rose is different
> 5 petals clearly (more than half) brown	> 50% of total petal surface area	The rose is not in a state where the entire surface area of the petals is visible.
1/100s shutter speed	1/10s shutter speed	Appears dark in indoor environments
The experiment ends on 7 June	Ended on 12 June	Roses lived longer than expected

VIII. Power Analysis

How many replications ?

De Silva et al. (2013) · Gerbera hybrida · mean vase life



+1.66 days — vinegar vs. control

+3.66 days — S+V vs. control

● Conservative estimate: uses Gerbera (not Rosa) and distilled water (not tap) as proxy

COHEN'S F

2.625

Large effect

CALCULATION

$$f = \frac{\sigma_m}{\sigma} = 1.496/0.57 = 2.625$$

Grand mean	12.557 days
SD of means (σm)	1.496
Baseline error (σ)	0.57 — controlled lab

De Silva et al. (2013)
Fully controlled lab
Low, stable error variance

→

Our study
Household conditions
Greater error variance anticipated

→

Approach
4 SD inflation scenarios
σ incrementally scaled ×1 → ×4

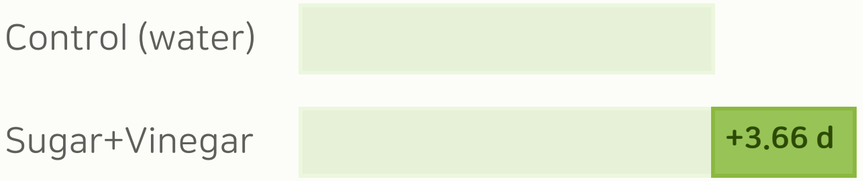
Scenario	SD	σ^2	Cohen's f	Reps needed	Power at n = 8
Original SD	0.57	0.325	2.625	—	~1.00
2× SD	1.14	1.300	1.312	3	~1.00
3× SD	1.71	2.924	0.875	5	0.9818
4× SD **: most conservative**	2.28	5.198	0.656	8	0.8390 ✓

8
selected n

4 reps/location × 2 locations — equal block sizes
Even at 4×SD (worst case), power **= 0.839 > 0.80** — exceeds the conventional threshold

e Silva et al. (2013)

Mean vase life by treatment — Gerbera hybrida

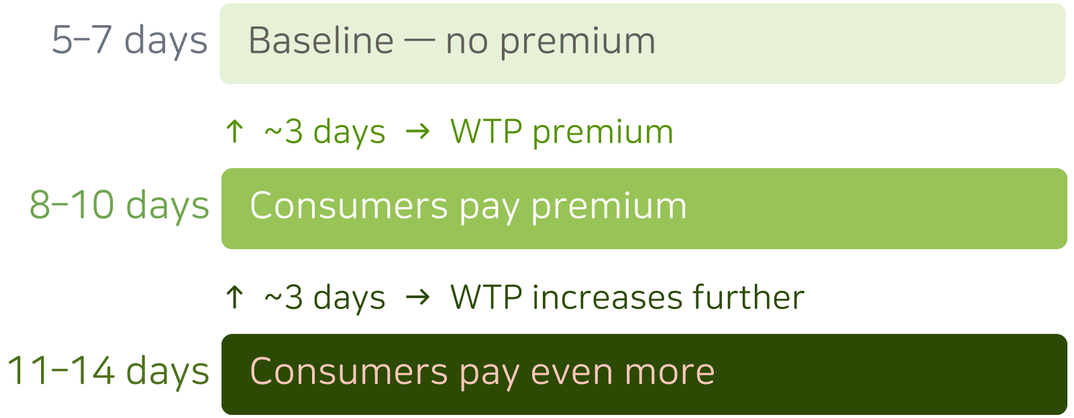


+3.66
days

The difference our design is powered to detect.

Rihn et al. (2014) — consumer WTP for rose arrangements

Single-species rose arrangements — WTP by vase-life category



Effect size target
= Difference consumers willing to pay for

IX. Analysis

So what is the best water solution?

| Two-way ANOVA with Blocking | Blocked 2×2 Factorial Design | RCBD

$$y_{ijkl} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_k + \varepsilon_{ijkl}$$

y_{ijkl}	**Response Variable** : Vase life (0.5 days)	$(\alpha\beta)_{ij}$	**Sugar × Vinegar interaction effect**
α_i	**Sugar main effect** (i = 1 : without, i = 2 : with)	Γ_k	**Block effect** (Location, k = 1, 2) - fixed
β_j	**Vinegar main effect** (i = 1 : without, i = 2 : with)	ε_{ijkl}	**Random error** ~ iid N(0, σ^2)

SUMMARY STATISTICS

Treatment	Mean (days)	SD (days)
Tap (Control)	7.56	1.72
Sugar	4.5	1.28
Vinegar	6.94	1.5
Sugar + Vinegar	**8.25**	**3.28**

Non - additive

Crossing lines, suggesting interaction between factors.

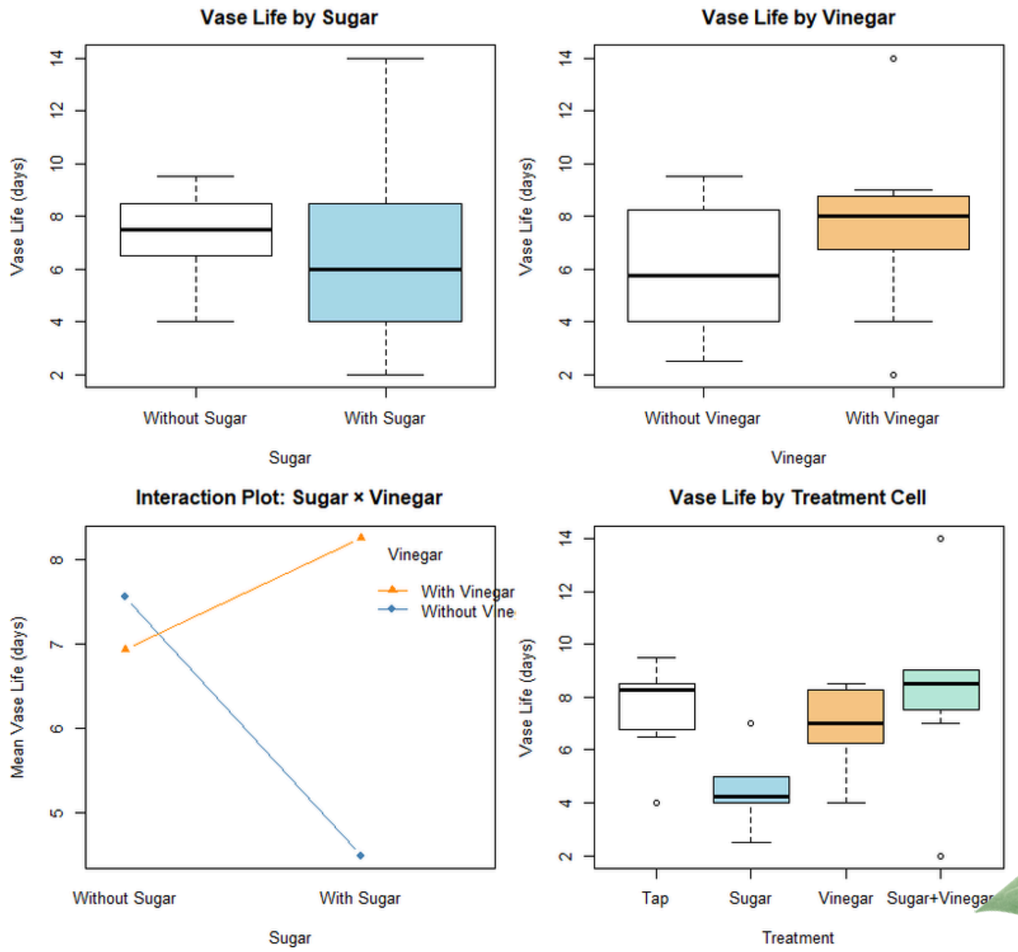
Treatment Effects

Sugar alone shortens vase life vs. Tap,
but Sugar + Vinegar yields the longest duration.

High Variability

Sugar + Vinegar cell exhibits significantly higher SD.
Indicating inconsistent performance.

⚠ Interaction limits the vailidity of marginal comparisons



Normality (Q-Q)

APPROX_OK

Central fit. Tail departures present, driven by extreme observations in Sugar+Vinegar cell

Constant Variance

VERIFIED

Residuals vs. Fitted plot shows no systematic fanning or funnel pattern. Variance is stable.

Serial Independence

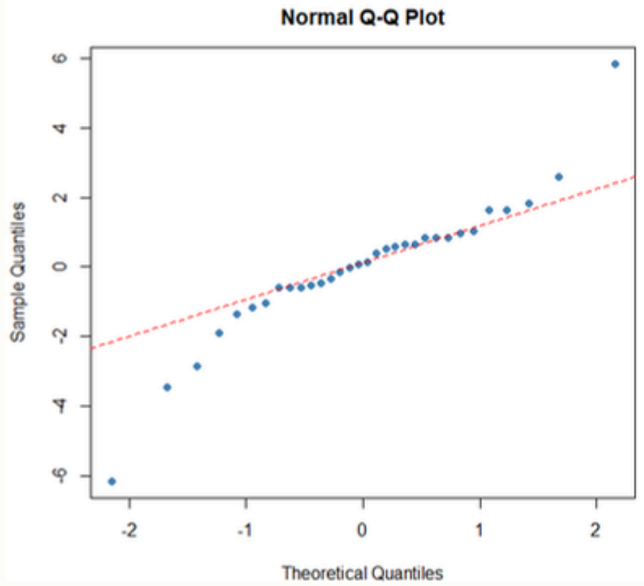
N/A - PASS

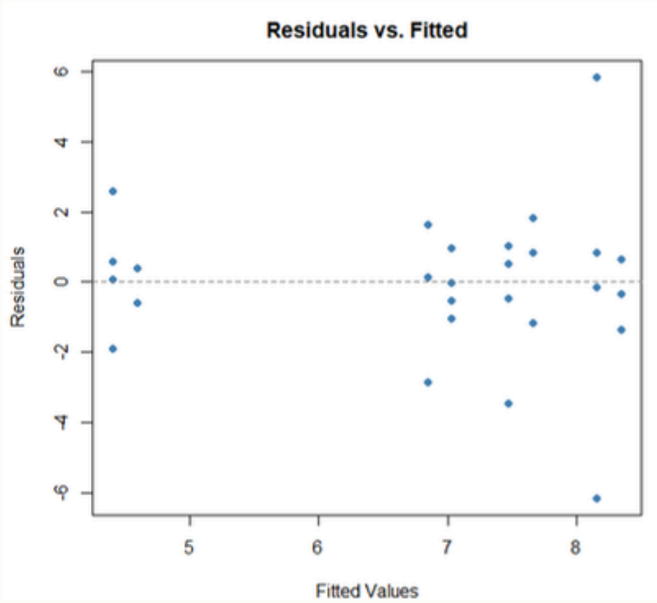
All units initiated simultaneously (29 May). No sequential run order.

Spatial Independence

APPROX_OK

Block 2 dominated by outliers. Block 1's semivariance remains negligible. Controlled randomization ensures spatial dependence to unlikely affect the analysis.



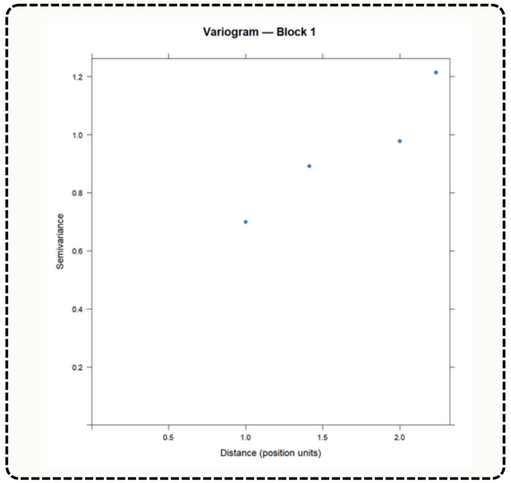


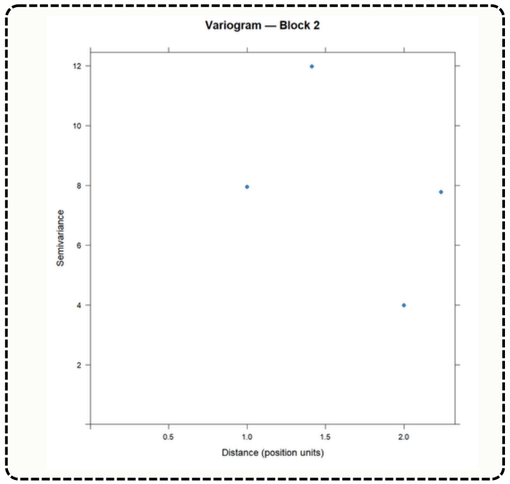
OUTLIER DETECTION

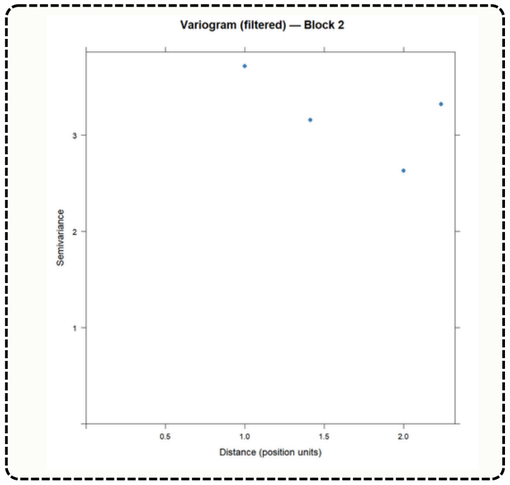
(t* = 3.52, α = 0.05, n = 32)

Observation	Studentized Residual (t)	Status	Details
ID 29	3.57	OUTLIER	Vase life: 14 days (Sugar+Vinegar, Block 2)
ID 30	-3.86	OUTLIER	Vase life: 2 days (Sugar+Vinegar, Block 2)

Variogram — Spatial Dependence Check







Variogram Patterns

- Block 1: Small trend (well below MSE 4.56).
- Block 2: Irregular. Driven by ID 29 & 30 outliers.

Mitigation Factors

- Limited resolution (2 × 8 grid); Only 4 distant classes
- Controlled indoor enviornment (lighting etc.)
- Randomised vase positions

Therefore,

Any potential spatial dependencs is unlikely substantially affect the final analysis.

POWER TRANSFORMATION

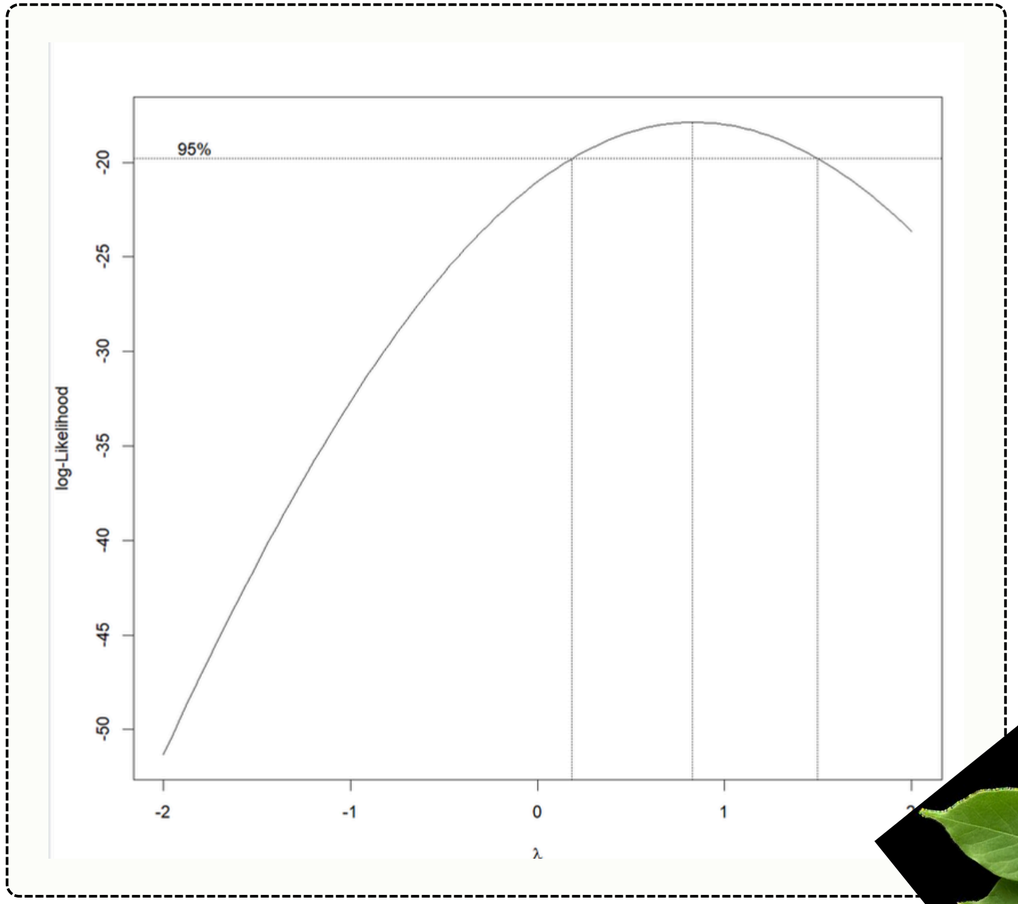
To assess whether transformation needed

$$\lambda = 0.83$$

95% Confidence Interval includes **1.0**

→ Transforming the response would not substantially improve the model

➡ **Original Scale Retained**



FULL DATA

Source	df	MS	F	p
Sugar	1	6.12	1.343	0.257
Vinegar	**1**	**19.53**	**4.282**	**0.048 ***
Block	1	0.28	—	—
Sugar:Vinegar	**1**	**38.28**	**8.393**	**0.007 ****
Residuals	27	4.56		

FILTERED DATA

Source	df	MS	F	p
Sugar	**1**	**9.15**	**4.479**	**0.044 ***
Vinegar	**1**	**15.25**	**7.462**	**0.011 ***
Block	1	0.87	—	—
Sugar:Vinegar	**1**	**36.01**	**17.622**	**<0.001 *****
Residuals	25	2.04		

EXISTENCE OF INTERACTION

As the interaction is **significant in both analyses**, subsequent interpretation must focus on **simple effects** rather than main effects.

INTERACTION ROBUSTNESS

Interaction SS remains stable (38.28 → 36.01), confirming that the significant interaction is **not driven by outliers** ID 29 and 30.

RELATIVE EFFICIENCY

$$RE = \frac{df_{Block} \cdot MS_{Block} + df_{Error} \cdot MS_{Error}}{(df_{Block} + df_{Error}) \cdot MS_{Error}}$$

Metric	Full Data	Filtered
MS_Block	0.28	0.87
MS_Error	4.56	2.04
RE Value	0.97	0.98

RE < 1

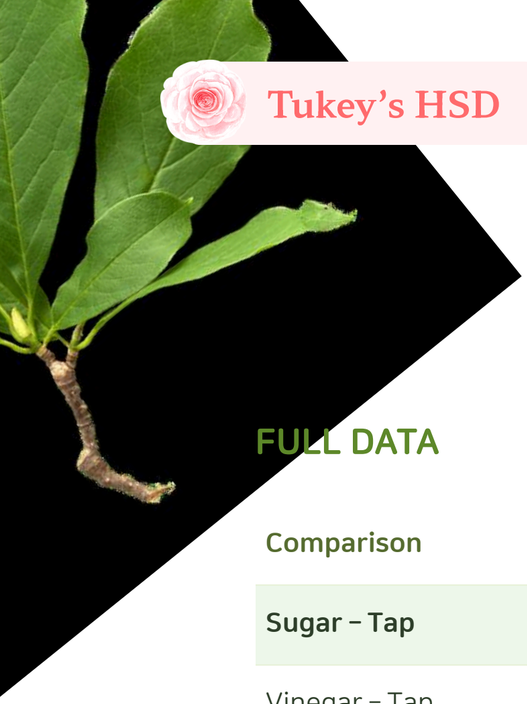
Blocking did not substantially reduce error variance

Environmental Similarity

Two locations were environmentally similar — between-location variability minimal

Design Purpose Preserved

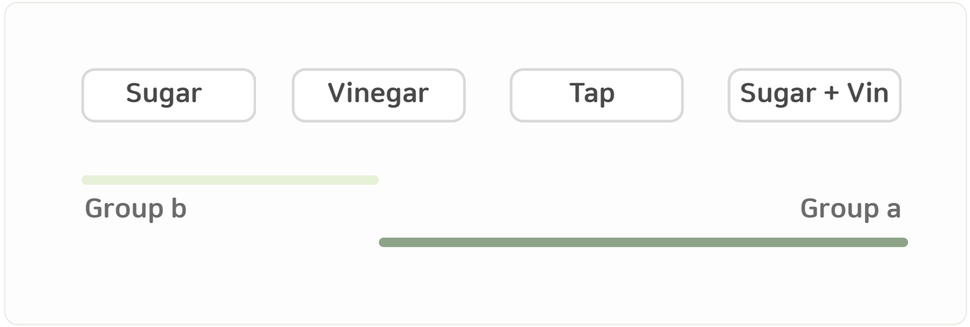
Blocking still served its design purpose as a pre-planned nuisance control (§5, 6)



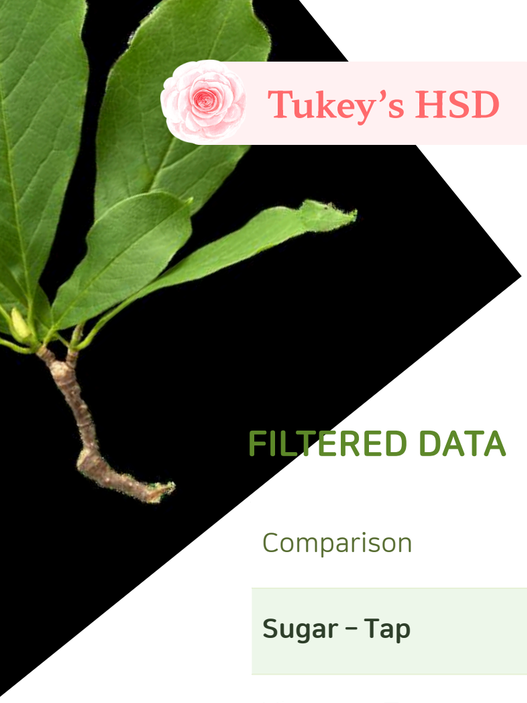
Tukey's HSD

FULL DATA

Comparison	Diff	95% CI	p adj
Sugar – Tap	**-3.06**	**[-5.98, -0.14]**	**0.037 ***
Vinegar – Tap	-0.63	[-3.55, 2.30]	0.936
Sugar+Vinegar – Tap	0.69	[-2.23, 3.61]	0.917
Vinegar – Sugar	2.44	[-0.48, 5.36]	0.127
Sugar+Vinegar – Sugar	**3.75**	**[+0.83, +6.67]**	**0.008 *** **
Sugar+Vinegar – Vinegar	1.31	[-1.61, 4.23]	0.614



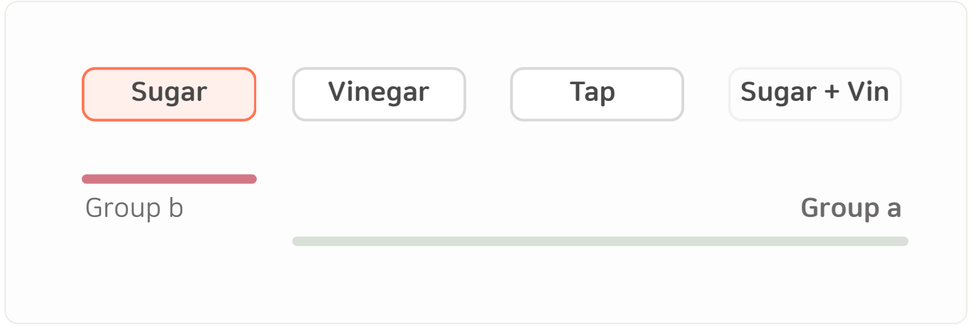
- **Sugar:** Significantly shorter vase life than Tap
- **Sugar+Vinegar vs. Sugar:** Reversal of Sugar's negative effect by Vinegar addition
- **Vinegar vs. Tap, Sugar+Vinegar vs. Tap:** No significant difference



Tukey's HSD

FILTERED DATA

Comparison	Diff	95% CI	p adj
Sugar – Tap	**-3.06**	**[-5.03, -1.10]**	**<0.001 ******
Vinegar – Tap	-0.63	[-2.59, 1.34]	0.818
Sugar+Vinegar – Tap	0.77	[-1.35, 2.89]	0.752
Vinegar – Sugar	**2.44**	**[+0.47, +4.40]**	**0.011 ******
Sugar+Vinegar – Sugar	**3.83**	**[+1.71, +5.96]**	**<0.001 ******
Sugar+Vinegar – Vinegar	1.4	[-0.73, 3.51]	0.293



- Same two significant comparisons retained; narrower CIs (MSE: 4.56 → 2.04)
- **Vinegar — Sugar:** Newly significant (p = 0.011) → full model underpowered for this comparison
- **Sugar:** Only distinct lower group (b)
- **Sugar+Vinegar:** Numerically highest mean, but not distinguishable from Tap or Vinegar in either analysis

SIMPLE EFFECT

Simple Effect	Comparison	Diff	p (Filtered)
Sugar (w/o Vin)	Sugar − Tap	**-3.06**	0.001 ***
Sugar (w/ Vin)	(S+V) − Vin	**1.4**	0.293
Vinegar (w/o Sug)	Vin − Tap	**-0.63**	0.818
Vinegar (w/ Sug)	(S+V) − Sug	**3.83**	0.0002 ***

↓ **Sugar Negativity:** Sugar alone significantly reduces vase life. However, this effect is neutralized when combined with Vinegar.

↑ **Vinegar Dependency:** Vinegar's benefit is strictly conditional; it only significantly increases vase life in the presence of sugar.

The data demonstrates a clear Sugar × Vinegar Interaction. Interpreting factors separately is misleading as **their efficacy is entirely dependent on co-presence.**

X. Conclusions

So what is the best water solution?

Sugar Alone Shortens Vase Life

Sugar - Tap : -3.06 days

p = 0.037

Halevy & Mayak (1981)

Microbial Proliferation

Surcose → Bacteria ↑ → Xylem Blocked → Vase Life ↓

Significant Sugar × Vinegar Interaction

Sugar + Vinegar & Tap & Vinegar (NS)

Full : F(1, 27) = 8.39, p = 0.007

Full : F(1, 25) = 17.62, p < .0.001

Acidification Overcomes Surcose Toxiticy

Vinegar : ph ↓ → Bacteria Surpressed → Nomral Uptake

CURRENT LIMITATION

n = 8

Low Sample Power

6 Sugar+Vinegar cell after outlier removal

2% / 0.6%

Restricted Concentration

Results specific to 2% sugar and 0.6% vinegar only — generalisability to other concentrations unknown

Outliers

Uncontrolled Variation

Outliers ID 29 (14 days) & 30 (2 days) both from this cell → opposing extremes

FUTURE DIRECTION

↑ Increase Replication

Resolve borderline non-significant comparisons (e.g., Tap vs. Vinegar)

Multi-level Factorial

Multiple Sugar and Vinegar concentrations

Monitor and record potential confounds within cell

Thank You

Q & A