

Quantifying the treatment effects on prolonging the
freshness of apples, bananas and avocados

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Research question



Indicator 12.3.1 - Global Food Loss and Waste

SDG target 12.3 has two components, Losses and Waste that should be measured by two separate indicators.

Sub-Indicator 12.3.1.a - Food Loss Index

The Food Loss Index (FLI) focuses on food losses that occur from production up to (and not including) the retail level. It measures the changes in percentage losses for a basket of 10 main commodities by country in comparison with a base period. The FLI will contribute to measure progress towards SDG Target 12.3.

Sub-Indicator 12.3.1.b - Food Waste Index

A proposal for measuring Food Waste, which comprises the retail and consumption levels is under development. UN Environment is taking the lead on this sub-indicator.



- Reducing food waste is a global problem.
- Finding a good way to keep the food fresh for a long time is important for our lives.
- Many startups that tackle this problem.
- Although those startups try to implement very complex methods, we can do something in much simpler way.
- Especially people like very simple way to store foods efficiently in their home.

Objective of experiment and Hypothesis

Started the experiment to find simpler ways to prolong the freshness of fruits by storing them in a specific manner to reduce the food waste.

- **The objective of our experiment:**

- Evaluate the average treatment effect (ATE) of different fruit storage methods in prolonging the freshness of fruits (apples, bananas, and avocados)

- **Our hypothesis:**

- Even when these fruits are all stored at a room temperatures, how they are stored can affect the longevity of their freshness.



Our treatments

- **Avocados**

- Control group: Just leave them on the desk
- Treatment group: Keep them in
 - i. Paper bags
 - ii. Ziplocs
 - iii. Aluminum foil

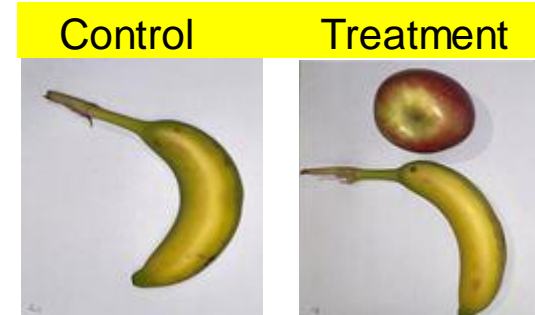


- **Bananas**

- Control group: Just leave them on the desk
- Treatment group: leave them next to apples

- **Apples**

- Control group: upside down
- Treatment group: upside up



Measurement Units

In a perfect world:

Freshies®

But there is no such metric...

Operationalizing 'Freshness':

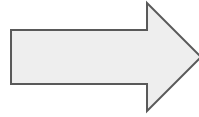
- Brown spots are common indicators of breakdown =>
- *Even minor changes in external appearance can reduce consumers' sensory and hedonic expectations and encourage rejection (Hooge et al., 2017).*
- First attempt, brownness/day
- Settled on detecting a significant change in hue.



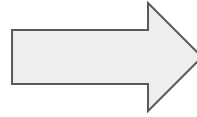
From:

<https://extension.umaine.edu/fruit/harvest-and-storage-of-tree-fruits/storage-disorders/>

Randomization

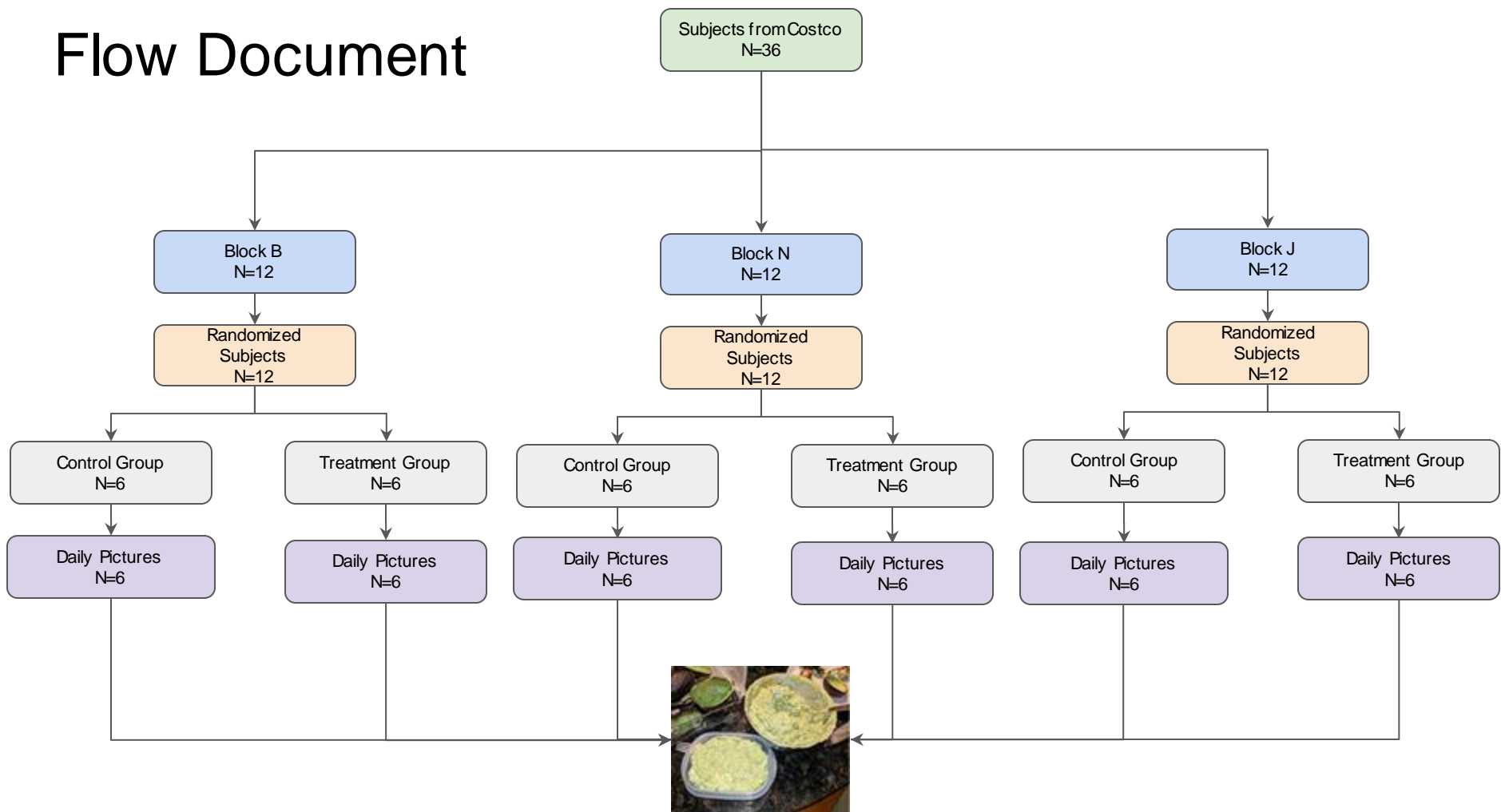


ID



No indication from covariate (weight)
that randomization was biased.

Flow Document



Experiment Design



Bananas

R	X0	X0	X0	X0	X0	X0	X0	X0	X0	X0
R	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0



Avocados

R	X0
R	-0

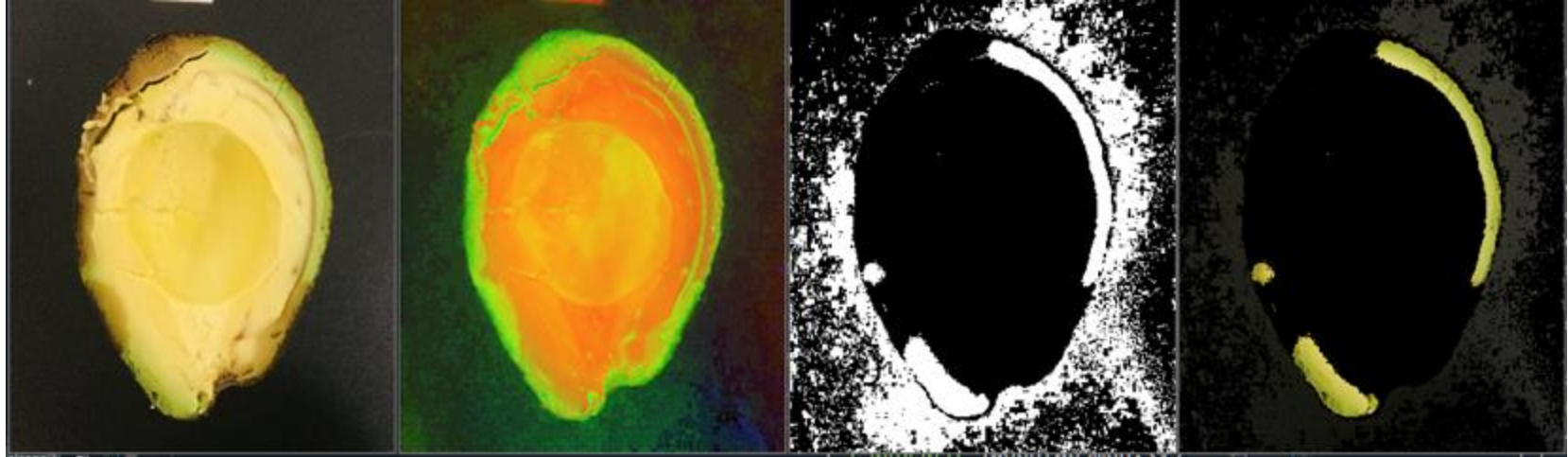
Between subjects comparison: items are only ever assigned to treatment or control.

Subject	Response 1	Response 2	Response 3
Apple	NA	NA	NA
Banana	d_turn	Weight	
Avocado	hue_turn	black_ratio	Weight

- We used apple for our pre-experiment and did not use apple during the main experiment
 - Color remain unchanged even after 25 days.
- Used avocado and banana for our main experiment.
 - Will focus on reporting on the findings from avocado experiment and will briefly talk the findings from analyzing the banana data at the end if there is time

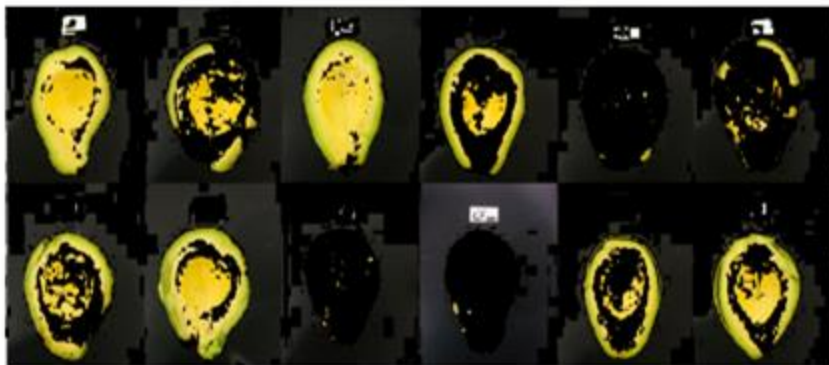


Picture taken on 12/1/2020

*Original**Decomposed into Hue,
Value and Saturation**Filter**Filtered*

- Fixed the condition that we are interested, which is the green part at the end of 8 days and measure the deviation from the target condition in a subjective and reproducible way.
 - We created filter using different values of Hue.

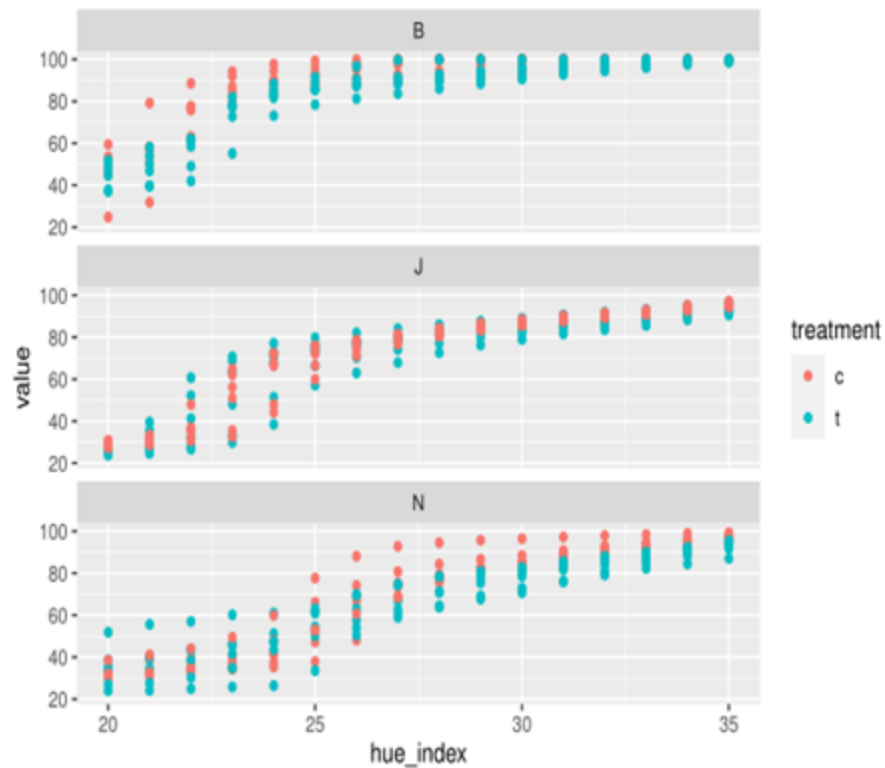
Minimum Hue = 24

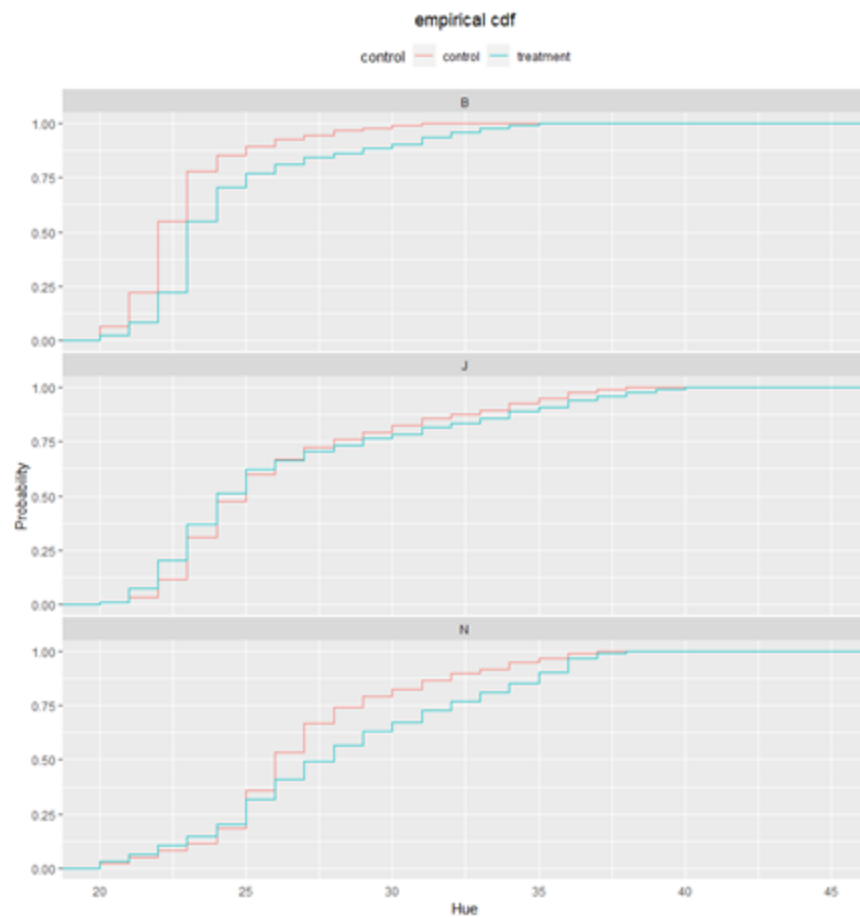
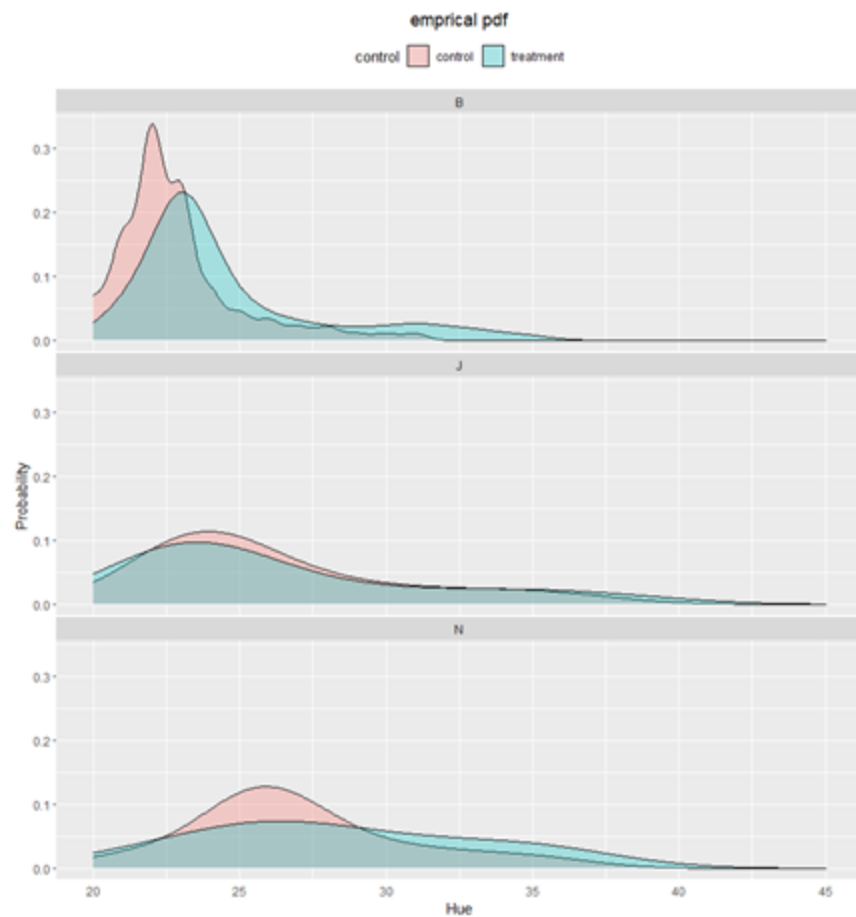


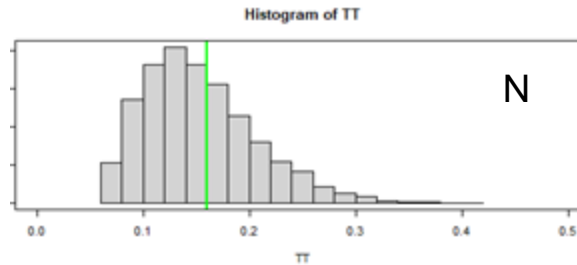
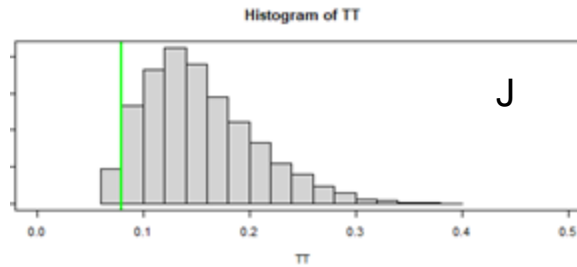
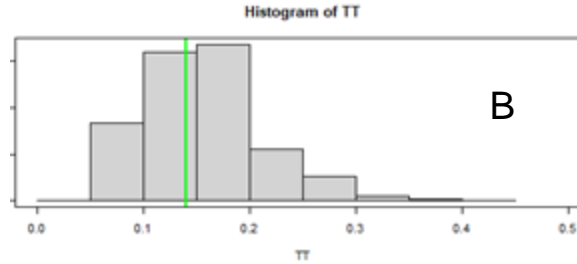
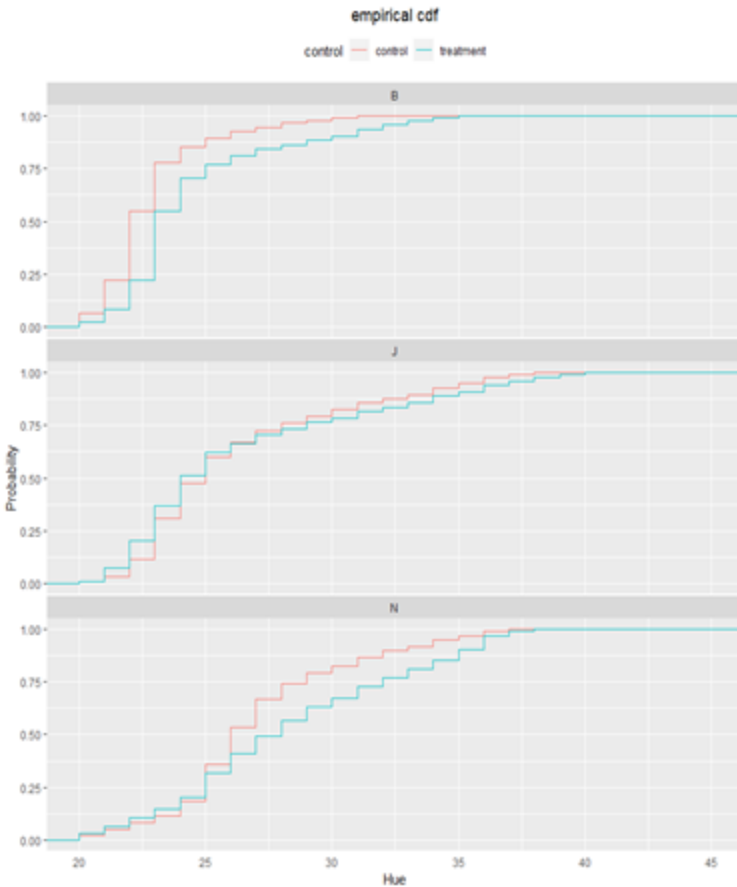
Minimum Hue = 26



Changes in black-ratio as function of hue





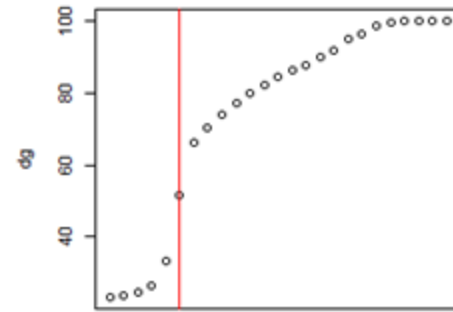
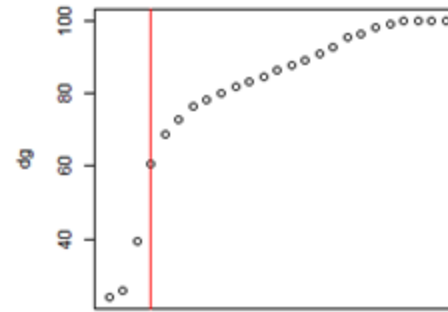
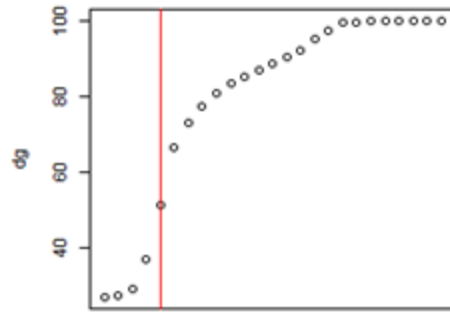
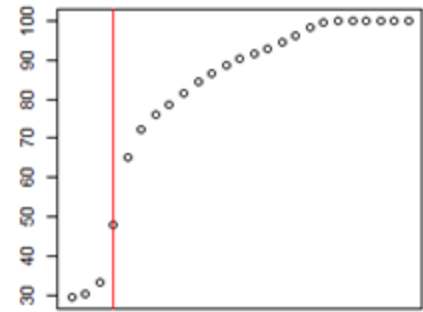


- Perform permutation (5000 times) tests based on the KS test statistic

Image processing

EDA and Data Cleaning

Analysis



Subject	Response 1
Avocado	Hue_turn
Banana	d_turn
Apple	NA

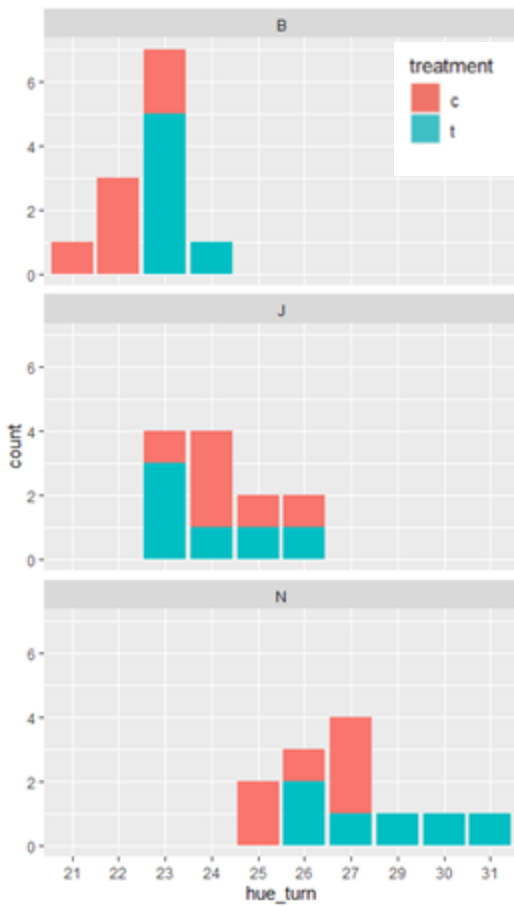
Used CUMSUM method

Used Bayesian Change point detection method

Image processing

EDA and Data Cleaning

Analysis



Block	Treat?	Hue_turn
B	c	22
B	t	23
J	c	24
J	t	24
N	c	26
N	t	28

short	<code>as.factor(treatment) + as.factor(block)</code>
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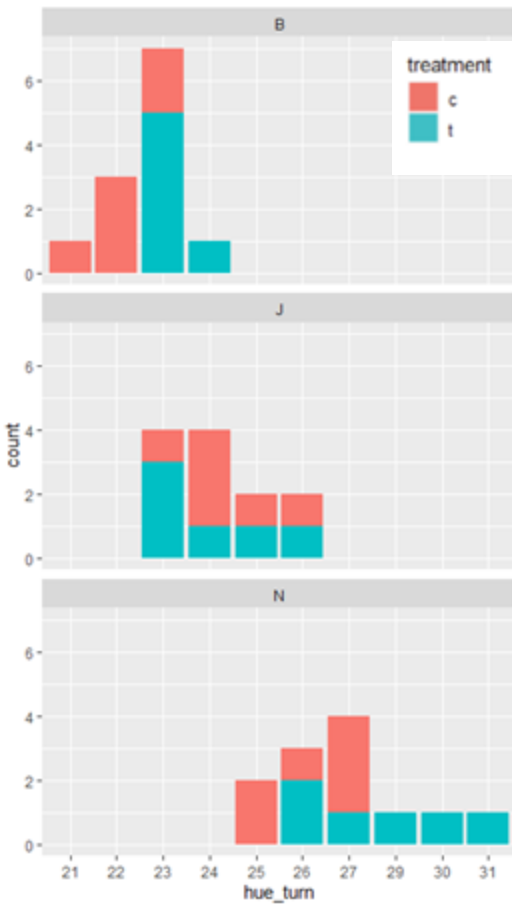
long	<code>as.factor(treatment)*as.factor(block)</code>
------	--

Parameter	short	long
constant	22.2***	22.17***
treatment	0.889**	1.00
J	1.5***	2.167***
N	4.5***	4***
t:J		-1.33
t:N		1

Image processing

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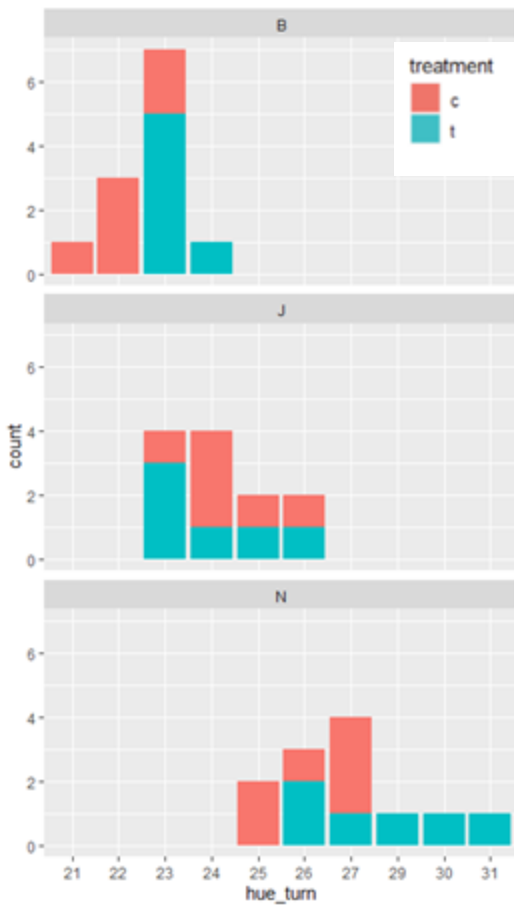
Block	Treat?	Hue_turn
B	c	22
B	t	23
J	c	24
J	t	24
N	c	26
N	t	28

mod_1	as.factor(treatment) + as.factor(block)	
mod_2	as.factor(treatment)*as.factor(block)	
Parameter	short	long
constant	22.2***	22.17***
treatment	0.889**	1.00
J	1.5***	2.167***
N	4.5***	4***
t:J		-1.33
t:N		1
	24.59	24

Image processing

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Analysis



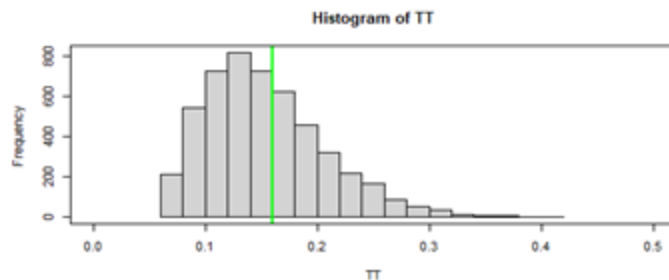
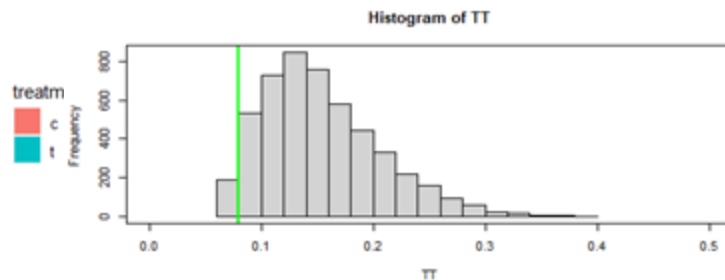
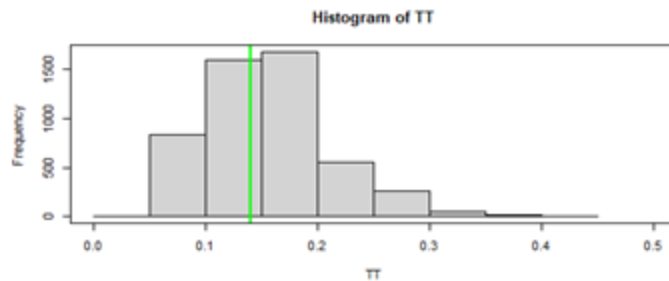
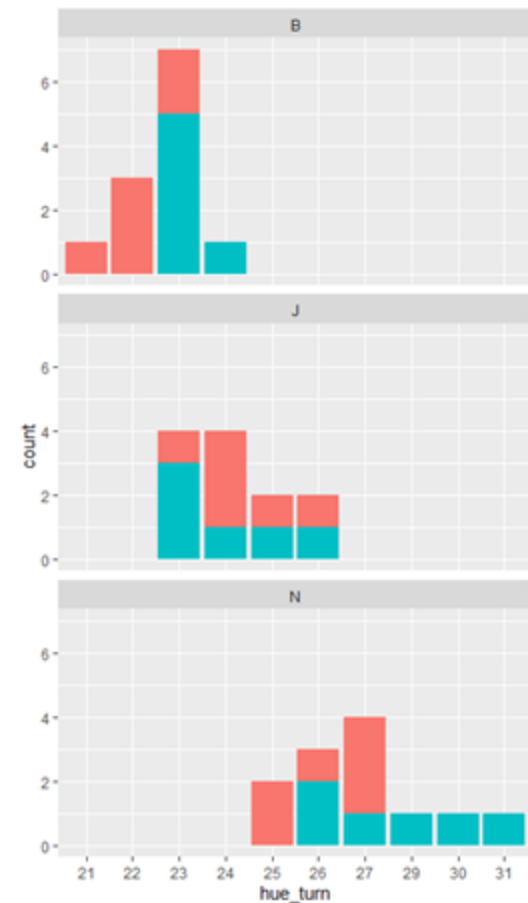
Block	Treat?	Hue_turn
B	c	22
B	t	23
J	c	24
J	t	24
N	c	26
N	t	28

mod_1	as.factor(treatment) + as.factor(block)	
mod_2	as.factor(treatment)*as.factor(block)	
Parameter	short	long
constant	22.2*** ● ○	22.17*** ● ○
treatment	0.889** ● ○	1.00 ● ○
J	1.5*** ○	2.167*** ○
N	4.5*** ●	4*** ●
t:J		-1.33 ○
t:N		1 ●
○	24.59	24
●	27.59	28.17

Image processing

EDA and Data Cleaning

Analysis



Response	Result
KS test	NO
Hue_turn	yes
Weight	YES

Is there treatment effect?

Which one would you eat?

1



2



3



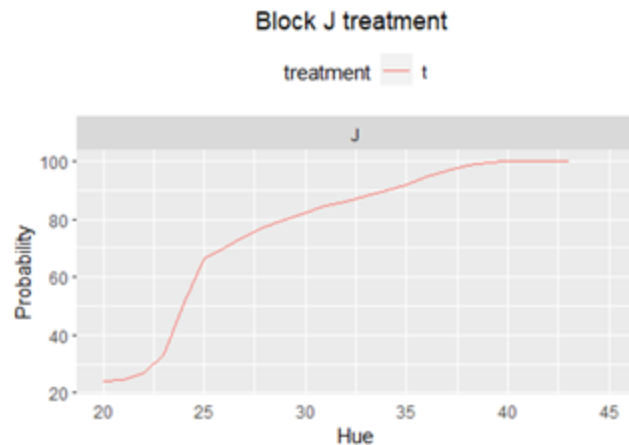
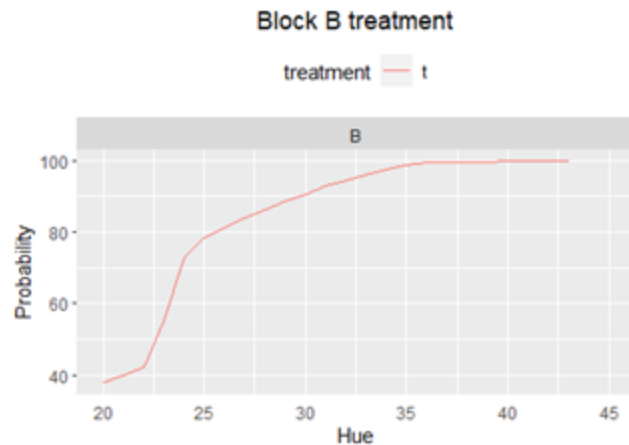
4



5



Concluding remarks



- Single value response may not be able to capture the treatment effect that you wish to capture
- Rather than using a scalar value, using a vector or hyperplane can be a solution.

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- Rather than using a scalar value, using a vector or hyperplane can be a solution.
- When you buy avocado, wrapping in a paper bag or aluminum foil can help. Don't put them inside a plastic bag



Power result



Response	Result
Hue_turn	0.23
Weight	1.0



Response	Result
d_turn	0.32
Weight	0.28

- Since KS test was performed based on one sample and the statistical significance of the KS statistic was estimated based on permutation, power of KS test was not evaluated.

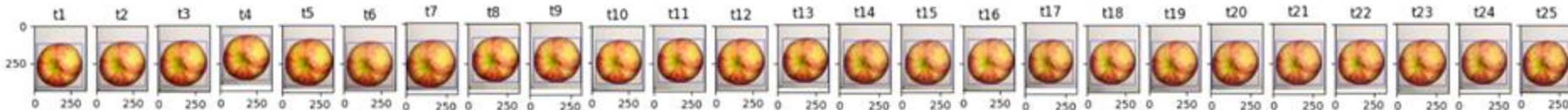
Concluding remarks

Purchased on : 10/25/20

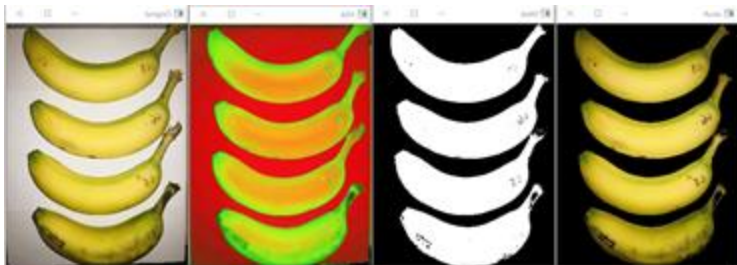
Condition on : 12/01/20



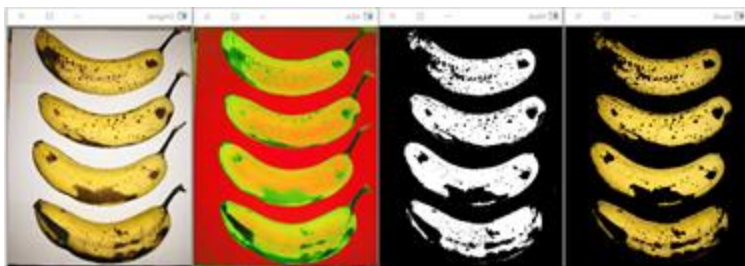
- Single value response may not be able to capture the treatment effect that you wish to capture
- Rather than using a scalar value, using a vector or hyperplane can be a solution.
- When you buy avocado, wrapping in a paper bag can help. Don't put them inside a plastic bag
- When you buy apple, you can leave it at room temperature for a long time.



Day 1



Day 10



- Single value response may not be able to capture the treatment effect that you wish to capture
- Rather than using a scalar value, using a vector or hyperplane can be a solution.
- When you buy avocado, wrapping in a paper bag can help. Don't put them inside a plastic bag
- When you buy apple, you can leave it at room temperature for a long time.
- If you want find out about our finding from analyzing the banana data, please visit the github page that will be available after Dec 17th.

Thank you

