Does Colour Affect Taste?

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Purpose

The purpose is to investigate whether the colour of a substance will affect the perceived taste of the test subjects.

Question

Given glasses of apple juice with various colours of food dye, will the subjects claim a difference in taste?

Hypothesis

Despite apple juice being the sole beverage utilized, the subjects will claim a difference in taste due to colour association with other flavours.

Independent Variable:

- The colour of the apple juice.

Dependent Variable:

- The perceived taste of the subjects.

Controlled Variables:

- The amount and brand of apple juice per cup (100mL).
- The amount and brand of food colouring per cup (four drops).
- The same type of disposable cups.
- Data collected and questions inquired.

Materials

- Ten test subjects.
- Four bottles of Great Value food colouring (red, blue, green, and yellow).
- Four 1L cartons of President's Choice apple juice (four litres of beverage in total).
- A measuring device.
- Forty stir sticks.
- Forty No Name 341 mL disposable cups (four per volunteer).
- One permanent marker.
- One pen for recording data.
- Ten sheets of paper.
- Sanitizing cleaner.
- Ten disposable gloves.

Procedure

Step 1:	Prior to starting the experiment, prepare four disposable cups with 100mL of apple juice. Using each shade of food colouring, test how many drops are required to cause a colour change. Use a stir stick to mix the substance. Dispose of when completed.
Step 2:	Sanitize the materials and surfaces utilized during this experiment, in compliance with Covid-19 regulations. Put on a pair of disposable gloves.
Step 3:	Record the following table onto a piece of paper, along with the number of the subject tested (1-10). The table will be utilized for recording data.

Chart Utilized

Labelling of Cup	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
A	/10	/10	/10	/10		/10
B	/10	/10	/10	/10		/10
C	/10	/10	/10	/10		/10
D	/10	/10	/10	/10		/10

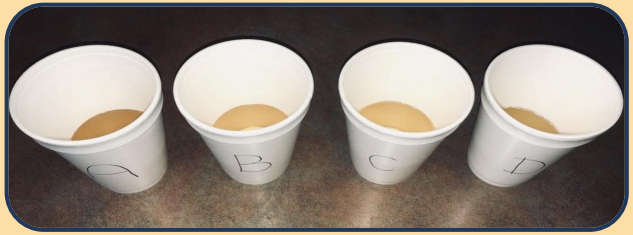
Procedure (Continued)

Step 4:	Using a permanent marker, label four disposable cups with the letters ‘A’, ‘B’, ‘C’, and ‘D’. Each individual cup should have one letter labelled upon it.
Step 5:	Measure and deposit 100mL of apple juice into each of the four cups.
Step 6:	Insert four drops of each food colouring (red, blue, green, and yellow) into Cup A, B, C, and D respectively. Mix thoroughly with a stir stick.
Step 7:	Line all beverages onto a test table before bringing the subject into the room. Ensure that the entirety of the preparation is not seen by the participant.

Procedure (Continued)

Step 8:	Usher the subject into the room. Briefly explain the instructions of the experiment.
Step 9:	Instruct the subject to ingest each coloured beverage in alphabetical order. Do not answer any questions posed and avoid displaying reactions. Doing so may reveal the purpose of the experiment and compromise results.
Step 10:	Once the subject has finished the beverages, inquire about each question indicated on the chart that was previously copied. Record the answers in the appropriate place.

Procedure (Continued)



Step 11:	Upon completion, usher the subject out of the room. Safely dispose of and sanitize the area in preparation for the next participant.
Step 12:	Repeat steps 2 - 12 with the remaining subjects, with identical measurements and execution.
Step 13:	Concluding the experiment, total the data collected and calculate the results per category. This will provide an indication of whether colour does affect taste perception.
Step 14:	Follow the same procedure except apple juice (without adding food colouring). This will serve as a control.

Results

Table 1: Statistical Analysis of the Overall Ratings of the Coloured Beverages and the Control

Statistical Analysis	*Red Beverage*	*Red Control*	*Blue Beverage*	*Blue Control*	*Green Beverage*	*Green Control*	*Yellow Beverage*	*Yellow Control*
Mean	6.6	6.6	5.8	6.6	6.0	6.6	5.6	6.6
Median	7.0	7.0	6.0	7.0	6.0	7.0	5.0	7.0
Mode	7.0	7.0	6.0	7.0	6.0	7.0	5.0	7.0
Variance	2.7	1.4	2.8	1.4	3.3	1.4	4.0	1.4
Range	5.0	4.0	6.0	4.0	6.0	4.0	7.0	4.0
S.D	2.4	1.2	1.7	1.2	1.8	1.2	2.0	1.2

Results (Continued)

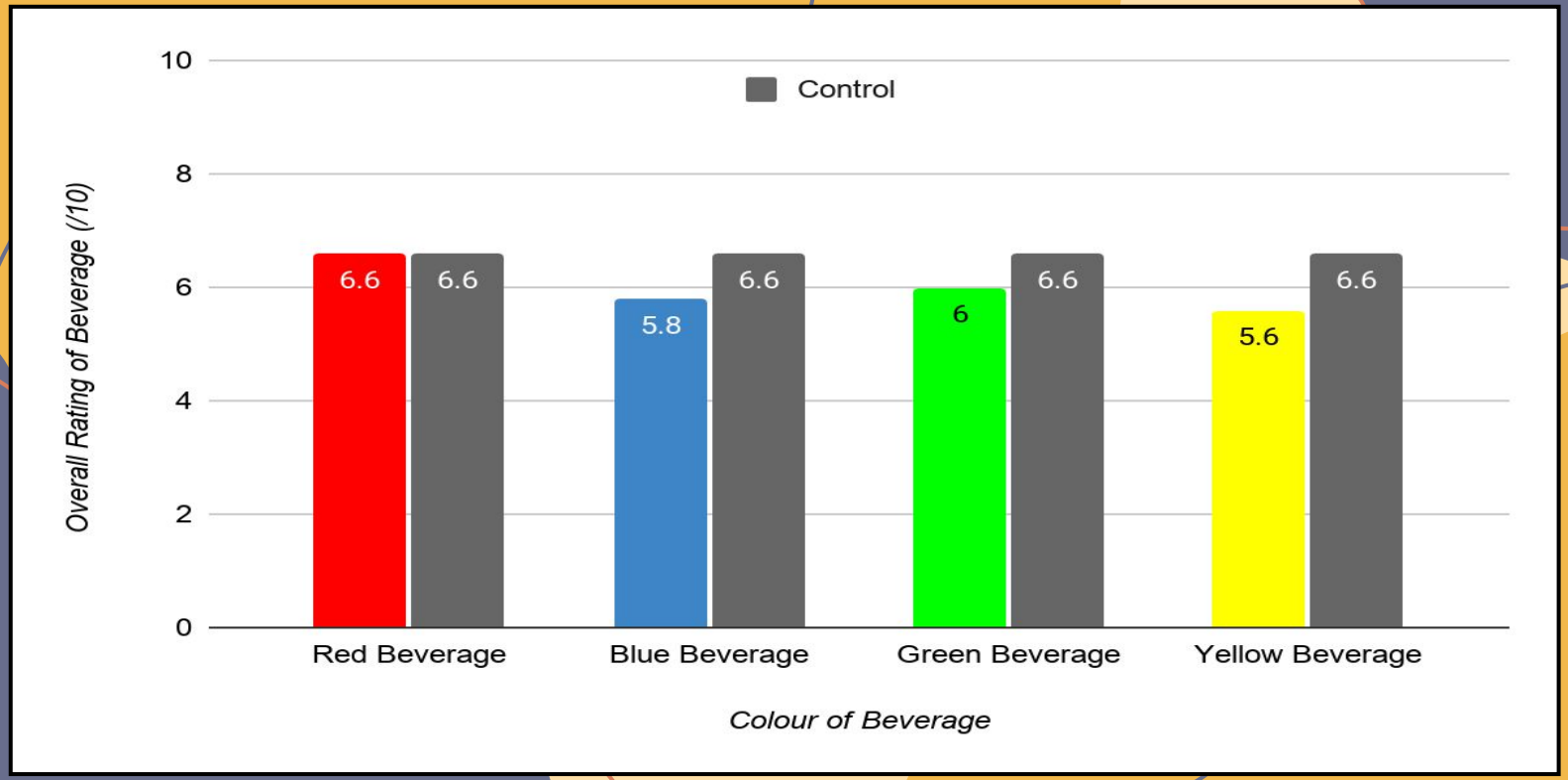


Figure 1: Comparison Between the Averaged Overall Ratings of the Coloured Beverages and the Control (n = 10)

Results (Continued)

Table 2: Number of Subjects that Perceived Particular Flavours of the Coloured Beverages

Perceived Flavour of Red Beverage	*Number of Subjects Who Perceived Such Flavour*	*Perceived Flavour of Blue Beverage*	*Number of Subjects Who Perceived Such Flavour*	*Perceived Flavour of Green Beverage*	*Number of Subjects Who Perceived Such Flavour*	*Perceived Flavour of Yellow Beverage*	*Number of Subjects Who Perceived Such Flavour*
Apple juice	8	Apple juice	7	Apple juice	6	Apple juice	8
Fruit punch	2	Blue raspberry	1	Green apple	3	Pineapple	1
		Grape	1	Pomegranate	1	Fruit punch	1
		Hawaiian punch	1				

Results (Continued)

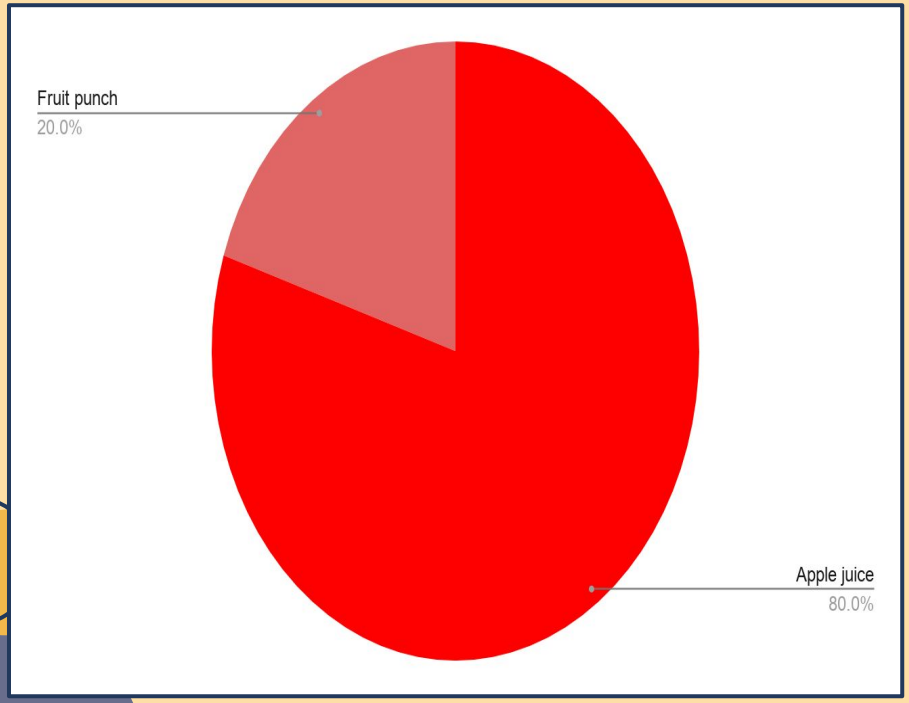


Figure 2A: Comparison of Speculated Flavours of the Red Beverage

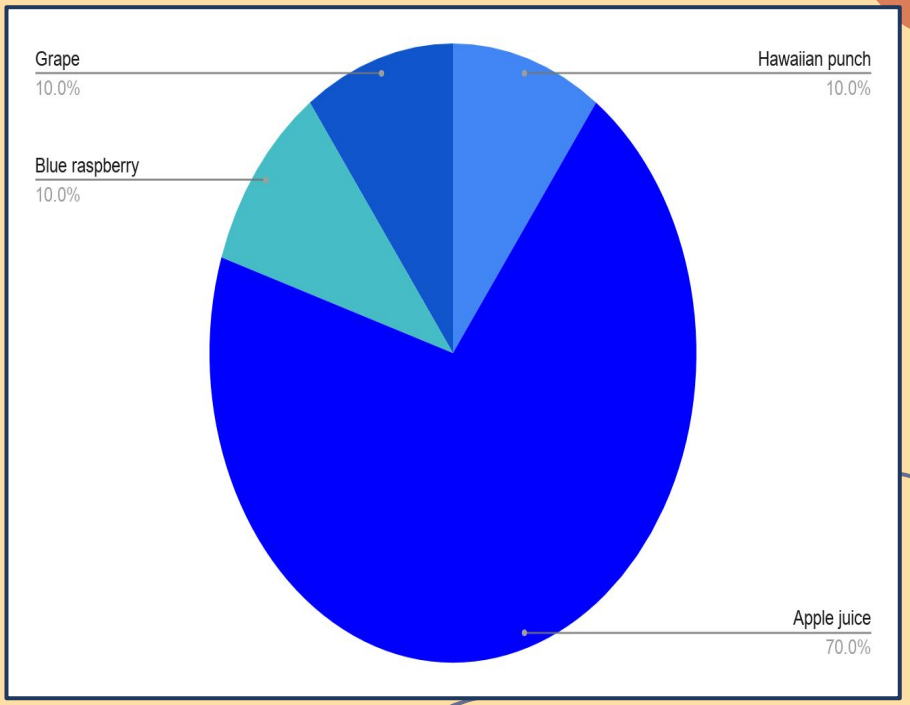


Figure 2B: Comparison of Speculated Flavours of the Blue Beverage

Results (Continued)

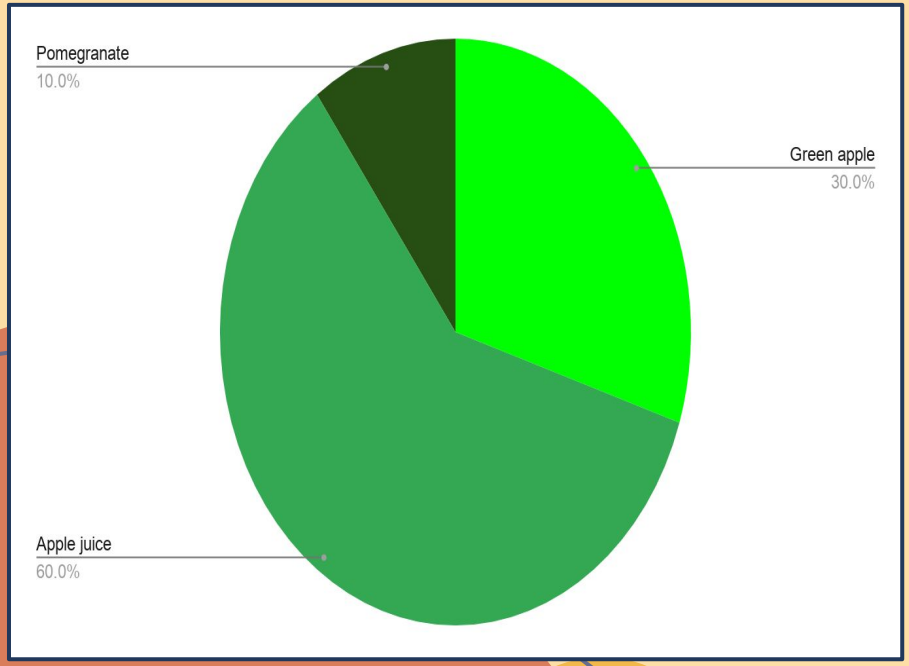


Figure 2C: Comparison of Speculated Flavours of the Green Beverage

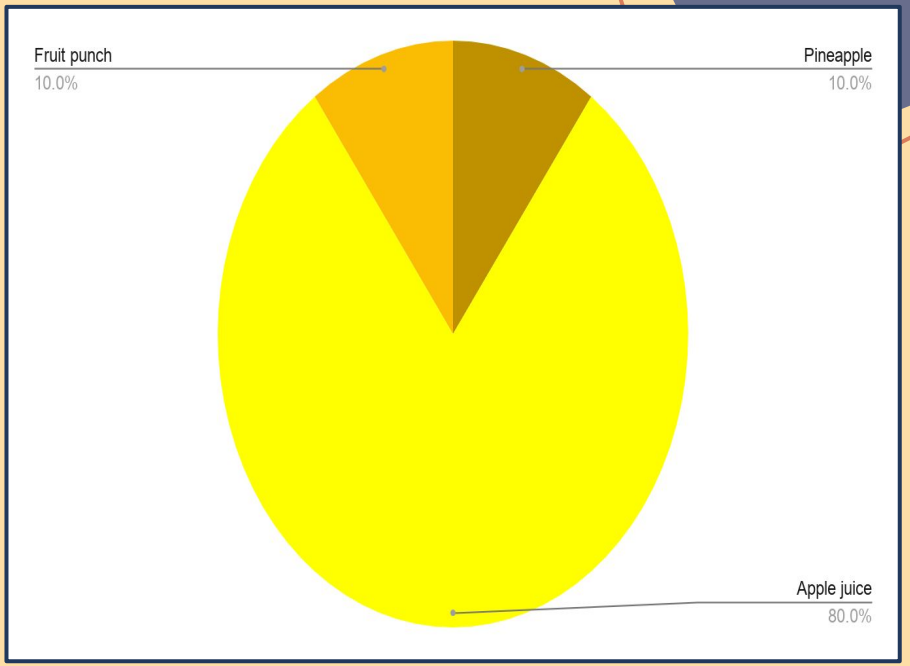


Figure 2D: Comparison of Speculated Flavours of the Yellow Beverage

Results (Continued)

Table 3: Statistical Analysis of Sourness & Bitterness Perception of the Coloured Beverages

Statistical Analysis	*Red Sourness*	*Red Bitterness*	*Blue Sourness*	*Blue Bitterness*	*Green Sourness*	*Green Bitterness*	*Yellow Sourness*	*Yellow Bitterness*
Mean	2.8	3.7	3.1	4.3	4.1	4.7	3.5	4.2
Median	2.0	3.0	3.0	4.0	4.0	5.0	3.0	4.0
Mode	2.0	3.0	4.0	3.0	4.0	5.0	1.0	3.0
Variance	2.8	4.5	3.4	4.9	3.4	3.1	4.5	4.4
Range	5.0	7.0	6.0	7.0	5.5	6.0	6.0	7.0
S.D	1.7	2.1	1.9	2.2	1.8	1.8	2.1	2.1

Results (Continued)

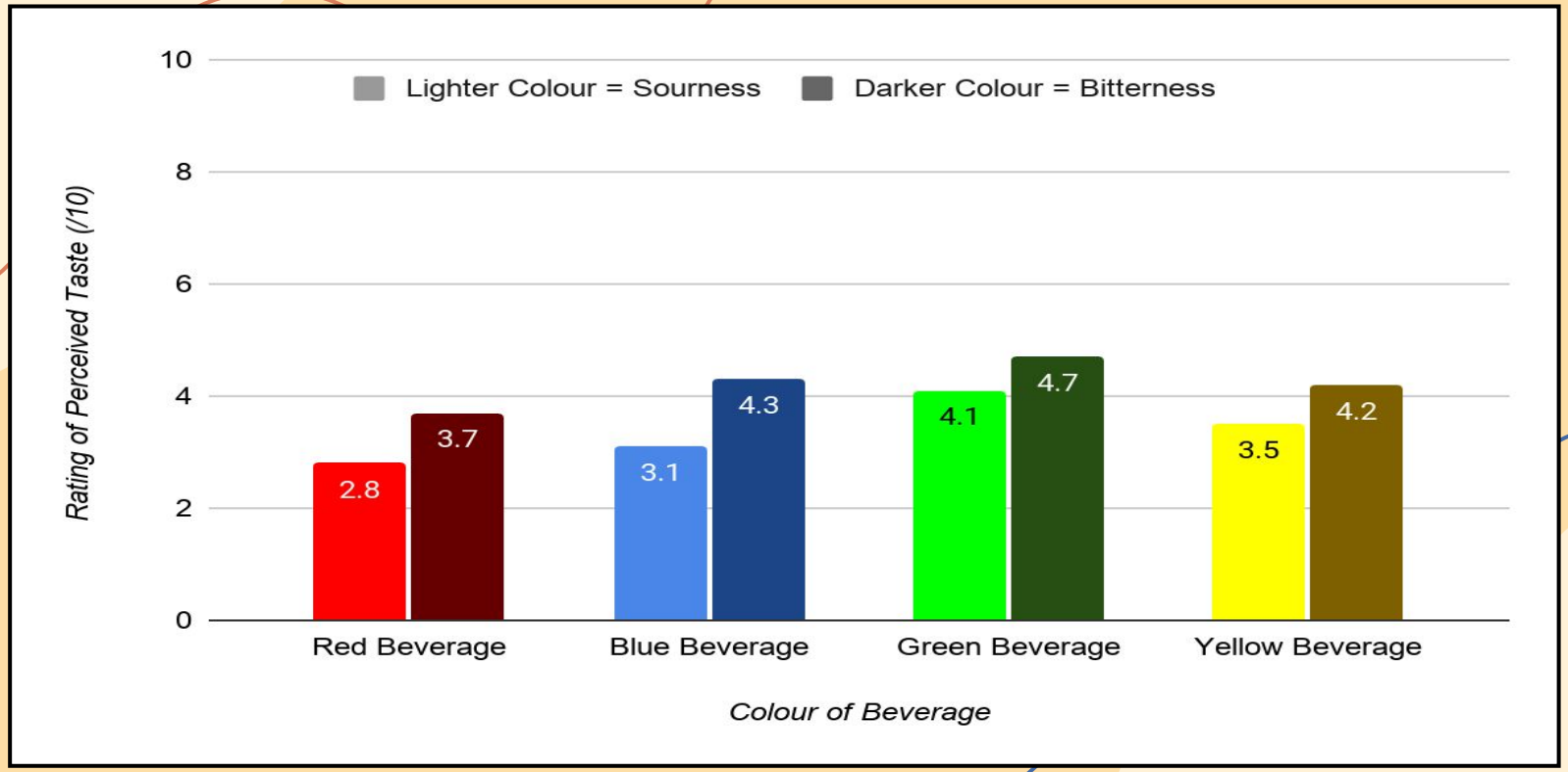


Figure 3: Comparison Between Averaged Values of Sourness & Bitterness Perception of the Coloured Beverages

Discussion

- 60% of the subjects **consistently identified the flavour** of the coloured beverages to be apple juice, thus the hypothesis was somewhat correct. Those with differing perceptions deemed flavours that were **affiliated with the colour** of the substance.

    - Despite not occurring vastly, this **arose linearly** among the coloured beverages. For instance, select subjects perceived the flavour of the red beverage to be fruit punch, which is commonly of a red hue.

- **Numerous senses** coincide to **generate a perception of taste**. As the senses of the subjects were not limited to visual perception, this may have distorted the hypothesis. As sensory aspects of sight, smell, and taste were permitted during this experiment, this **increased the likelihood** of apple juice being identified.

Discussion (Continued)

- A component of this experiment was to inspect the potential linkage between colour and the subcategories of taste, as well as overall appeal. Despite the majority of the subjects distinguishing the correct beverage, categorical ratings of **taste aspects varied**.

- Flavour satisfaction was **greater among the control** as opposed to the coloured beverages. The rating of the red beverage was parallel to the control, while the remaining beverages **posed a differential**. Red hues are affiliated with sweetness and have elevated satisfaction. The yellow beverage received the lowest ranking, which is customarily associated with sourness and have reduced degrees of appeal.

- Since there is **no variation** among the substances, the possible explanation of such may be an occurrence of **colour's alteration of taste interpretation**. However, the data accumulated is **inconclusive** and cannot confirm this implication.

Discussion (Continued)

- The juice contains 30 grams of carbohydrates per serving, which are predominantly classified as sugars. One could hypothesize that the substance would receive **elevated ratings of sweetness**. The sodium concentration is minimal, thus the ratings of saltiness are **projected to be low**.
    - The assumptions regarding the interpretation of these flavours **reflect the results**. Additives of ascorbic acid, which is deemed as sour, however, would likely be **counteracted by the sugar contents**.
- The classification of sourness and bitterness frequently corresponds, yet **a differential** between the two is present. As there ceases to be an ingredient to transpire the identification of these flavours, **the ratings are questionable.**

Discussion (Continued)

- To further investigate the phenomenon regarding sourness and bitterness, numerous **correlation tests** were conducted. The sourness and bitterness ratings of each coloured beverage were juxtaposed to **disclose a potential correspondence**.

- The **R-value** of the red substance, a statistical unit used to express the magnitude of correlation, was 0.6055. The blue beverage received an R-value of 0.3711. The correlation between the variables of the green substance was deemed 0.4341, and 0.4495 for the yellow beverage.

- A **moderate correlation** was present between the categorical ratings of the red substance. Collectively, the remaining beverage hues received a **positive, yet weak association**. The degree of variable relation is determined by proximity to zero and parallelism between values. **Increased sample** size could enhance the degree of correlation between the data accumulated.

Discussion (Continued)

- Various senses coincide to generate a sense of flavour. Numerous test subjects **identified the beverage** subsequent to smelling the substance. Upon repetition, **impairing the subject's sense of smell** would derive data on the basis of solely visual and gustatory perception.

    - Measuring and concocting the beverages was tedious and required immense precision. **Preparation consumed greater time** as opposed to the collection of data, which could be altered to enhance overall efficiency.

- **Additional execution** is ideal to accumulate results more conclusive regarding colour's influence on taste perception.

Sources of Error

- Systematic error derived from the measuring device utilized during the experiment. The **quantities were inaccurately labelled** upon the glass, resulting in displacement of the juice-dye ratio. Thus, beverage measurements were inconsistent.

Contamination of dye between beverages arose due to random error. Hints of dye were spotted in undesignated cups, concocting a discoloured substance. This discolouration potentially compromised results as the improper colour was associated with a different taste.

- **Faulty dispensing of dye** also occurred. As opposed to four drops of dye, some cups received more or less than. The enhanced presence or absence of dye manipulated the colour intensity of the beverage, which may distort the flavour aspect ratings.

Conclusion

Through experimental completion, the hypothesis was partially supported as select subjects claimed a difference in taste due to colour association with other flavours, despite apple juice being the sole beverage utilized.

Acknowledgements

- I'd like to extend **immense gratitude** to the subjects who partook in this experiment: *E. Vatcher, A. Oldford, A. Lowery, C. Saunders, M. Burden, G. Critchley, J. Samson, K. Robinson, L. Samson, and C. Robinson*. The avid engagement and sophistication they contributed made this project possible.

- **Many thanks** are also bestowed to **Ms. Yvonne Dawe**, my chemistry instructor, for providing pivotal guidance and scientific expertise. She assisted in the brication and analysis of this experiment, which too made this project possible.

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Appendix: Log Book

Results of Apple Juice and Food Colouring Solution: Subject #1

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	1/10	8/10	1/10	3/10	Fruit punch	9/10
Blue (B)	2/10	8/10	1/10	3/10	Hawaiian punch	7/10
Green (C)	2/10	6/10	1/10	4/10	Green apple	7/10
Yellow (D)	1/10	5/10	1/10	3/10	Pineapple	8/10

Appendix: Log Book

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #1*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	3/10	5/10	1/10	4/10	Apple juice	7/10
Blue (B)	3/10	5/10	1/10	4/10	Apple juice	7/10
Green (C)	3/10	5/10	1/10	4/10	Apple juice	7/10
Yellow (D)	3/10	5/10	1/10	4/10	Apple juice	7/10

Appendix: Log Book

Results of Apple Juice and Food Colouring Solution: Subject #2

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	2/10	4/10	0/10	3/10	Apple juice	7/10
Blue (B)	4/10	5/10	2/10	3/10	Apple juice	6/10
Green (C)	4/10	6/10	2/10	3/10	Apple juice	6/10
Yellow (D)	5/10	6/10	3/10	4/10	Apple juice	5/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #2*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	4/10	6/10	0/10	2/10	Apple juice	7/10
Blue (B)	4/10	6/10	0/10	2/10	Apple juice	7/10
Green (C)	4/10	6/10	0/10	2/10	Apple juice	7/10
Yellow (D)	4/10	6/10	0/10	2/10	Apple juice	7/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #3

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	4/10	2/10	0/10	8/10	Apple juice	7/10
Blue (B)	4/10	4/10	2/10	8/10	Apple juice	7/10
Green (C)	4/10	4/10	2/10	8/10	Apple juice	8/10
Yellow (D)	2/10	2/10	2/10	8/10	Apple juice	7/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #3*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	2/10	2/10	2/10	8/10	Apple juice	7/10
Blue (B)	2/10	2/10	2/10	8/10	Apple juice	7/10
Green (C)	2/10	2/10	2/10	8/10	Apple juice	7/10
Yellow (D)	2/10	2/10	2/10	8/10	Apple juice	7/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #4

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	2/10	6/10	3/10	3/10	Apple juice	7/10
Blue (B)	4/10	6/10	3/10	4/10	Apple juice	5/10
Green (C)	5/10	4/10	2/10	5/10	Apple juice	7/10
Yellow (D)	5/10	6/10	1/10	6/10	Apple juice	5/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #4*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	4/10	8/10	1/10	5/10	Apple juice	7/10
Blue (B)	4/10	8/10	1/10	5/10	Apple juice	7/10
Green (C)	4/10	8/10	1/10	5/10	Apple juice	7/10
Yellow (D)	4/10	8/10	1/10	5/10	Apple juice	7/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #5

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	6/10	3/10	2/10	5/10	Apple juice	7/10
Blue (B)	7/10	3/10	2/10	6/10	Apple juice	4/10
Green (C)	6/10	3/10	3/10	5/10	Apple juice	6/10
Yellow (D)	7/10	2/10	2/10	5/10	Apple juice	5/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #5*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	4/10	5/10	2/10	5/10	Apple juice	6/10
Blue (B)	4/10	5/10	2/10	5/10	Apple juice	6/10
Green (C)	4/10	5/10	2/10	5/10	Apple juice	6/10
Yellow (D)	4/10	5/10	2/10	5/10	Apple juice	6/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #6

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	3/10	5/10	2/10	6/10	Apple juice	5/10
Blue (B)	1/10	8/10	1/10	5/10	Blue raspberry	6/10
Green (C)	6/10	6/10	3/10	5/10	Green apple	6/10
Yellow (D)	3/10	5/10	4/10	3/10	Apple juice	6/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #6*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	3/10	5/10	2/10	5/10	Apple juice	5/10
Blue (B)	3/10	5/10	2/10	5/10	Apple juice	5/10
Green (C)	3/10	5/10	2/10	5/10	Apple juice	5/10
Yellow (D)	3/10	5/10	2/10	5/10	Apple juice	5/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #7

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	5/10	6.5/10	4/10	4/10	Apple juice	5/10
Blue (B)	4/10	7.5/10	3/10	4/10	Grape	5/10
Green (C)	6.5/10	5/10	5/10	6/10	Pomegranate	4/10
Yellow (D)	6/10	5/10	5/10	6/10	Fruit punch	4/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #7*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	6/10	5/10	5/10	4/10	Apple juice	5/10
Blue (B)	6/10	5/10	5/10	4/10	Apple juice	5/10
Green (C)	6/10	5/10	5/10	4/10	Apple juice	5/10
Yellow (D)	6/10	5/10	5/10	4/10	Apple juice	5/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #8

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	2/10	7/10	0/10	2/10	Fruit punch	4/10
Blue (B)	2/10	5/10	0/10	7/10	Apple juice	6/10
Green (C)	3/10	5/10	0/10	6/10	Green apple	6/10
Yellow (D)	3/10	4/10	0/10	4/10	Apple juice	5/10

Appendix: Log Book (Continued)

Results of Apple Juice Without Food Colouring (Control) : Subject #8

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	3/10	6/10	0/10	4/10	Apple juice	6/10
Blue (B)	3/10	6/10	0/10	4/10	Apple juice	6/10
Green (C)	3/10	6/10	0/10	4/10	Apple juice	6/10
Yellow (D)	3/10	6/10	0/10	4/10	Apple juice	6/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #9

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	2/10	7/10	1/10	1/10	Apple juice	9/10
Blue (B)	2/10	7/10	1/10	1/10	Apple juice	9/10
Green (C)	3/10	7/10	2/10	2/10	Apple juice	8/10
Yellow (D)	3/10	7/10	1/10	1/10	Apple juice	9/10

Appendix: Log Book (Continued)

*Results of Apple Juice **Without** Food Colouring (Control) : Subject #9*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	4/10	7/10	2/10	3/10	Apple juice	9/10
Blue (B)	4/10	7/10	2/10	3/10	Apple juice	9/10
Green (C)	4/10	7/10	2/10	3/10	Apple juice	9/10
Yellow (D)	4/10	7/10	2/10	3/10	Apple juice	9/10

Appendix: Log Book (Continued)

Results of Apple Juice and Food Colouring Solution: Subject #10

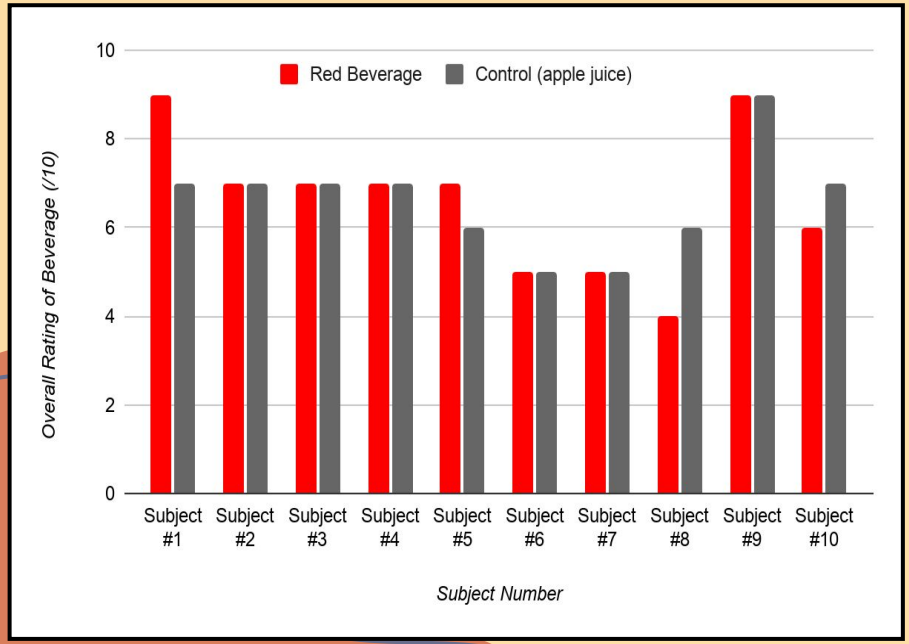
Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	1/10	7/10	1/10	2/10	Apple juice	6/10
Blue (B)	1/10	4/10	1/10	2/10	Apple juice	3/10
Green (C)	1/10	4/10	1/10	3/10	Apple juice	2/10
Yellow (D)	1/10	4/10	1/10	2/10	Apple juice	2/10

Appendix: Log Book (Continued)

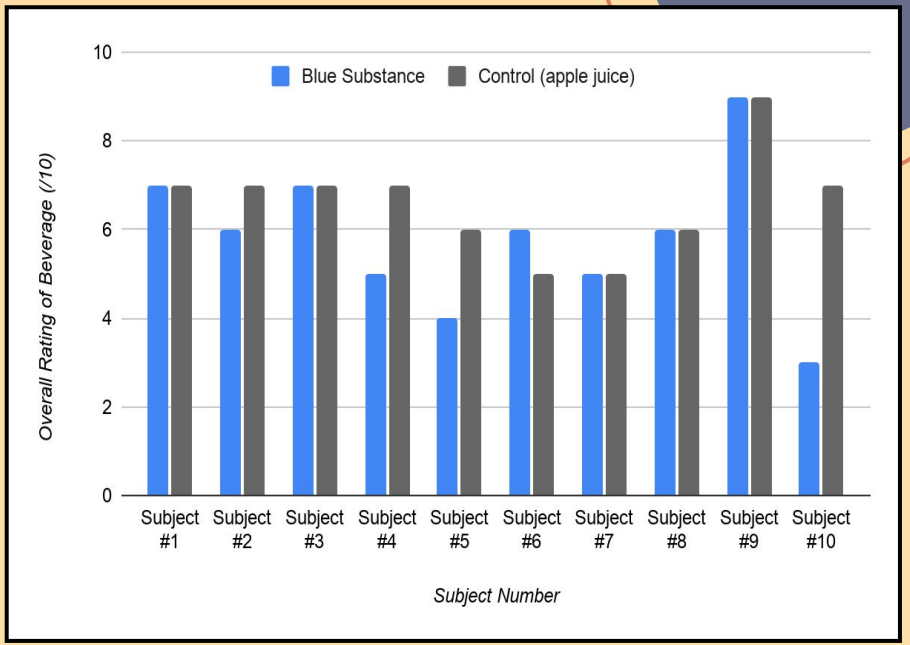
*Results of Apple Juice **Without** Food Colouring (Control) : Subject #10*

Colour of Apple Juice	*Rating of Sourness*	*Rating of Sweetness*	*Rating of Saltiness*	*Rating of Bitterness*	*Perceived Flavour of Beverage*	*Overall Rating of Beverage*
Red (A)	1/10	3/10	2/10	1/10	Apple juice	7/10
Blue (B)	1/10	3/10	2/10	1/10	Apple juice	7/10
Green (C)	1/10	3/10	2/10	1/10	Apple juice	7/10
Yellow (D)	1/10	3/10	2/10	1/10	Apple juice	7/10

Appendix Log Book (Continued)

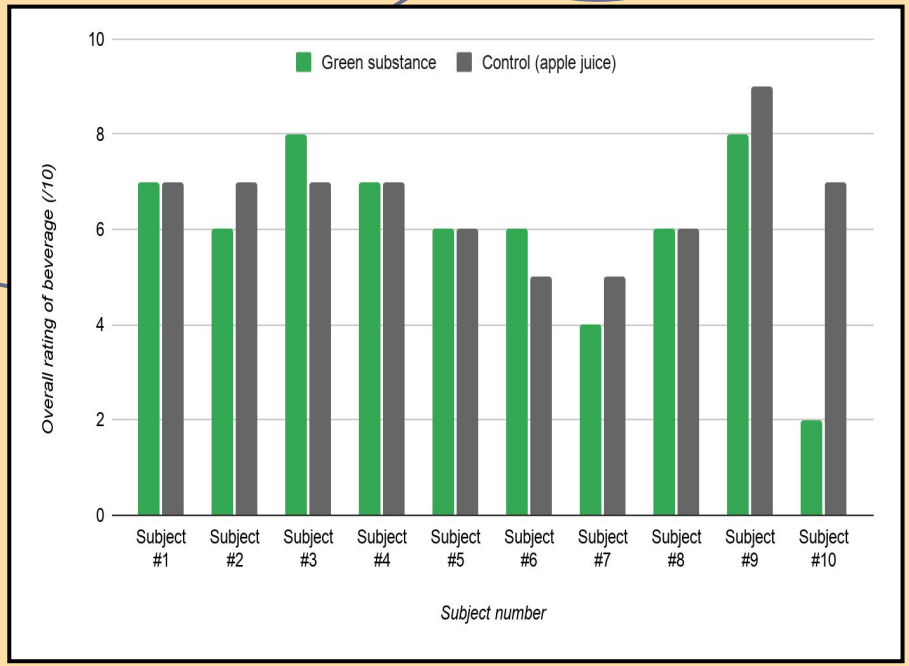


Comparison Between Overall Ratings of the Red Beverage & the Control

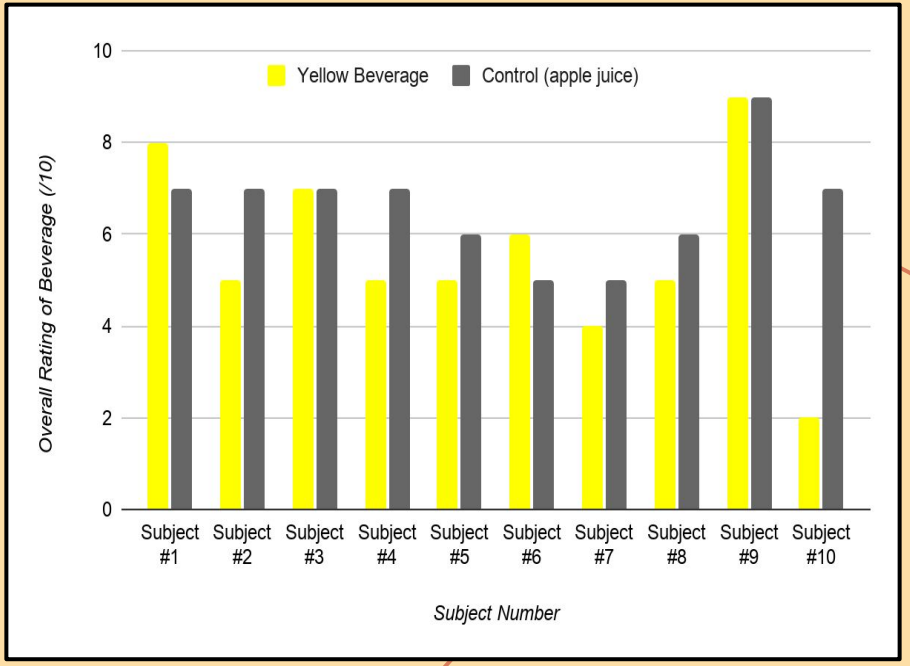


Comparison Between Overall Ratings of the Blue Beverage & the Control

Appendix Log Book (Continued)

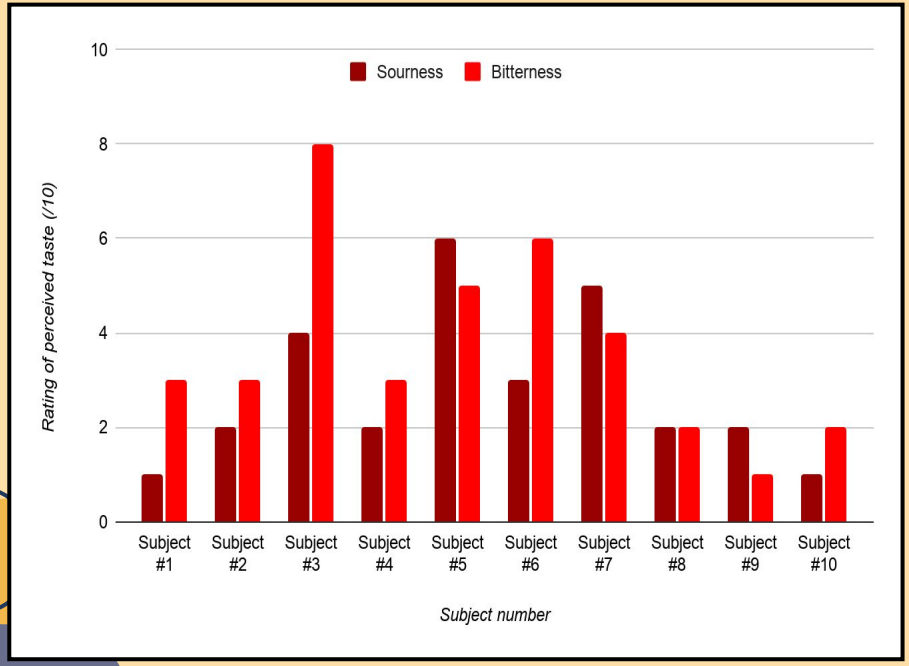


Comparison Between Overall Ratings of the Green Beverage & the Control

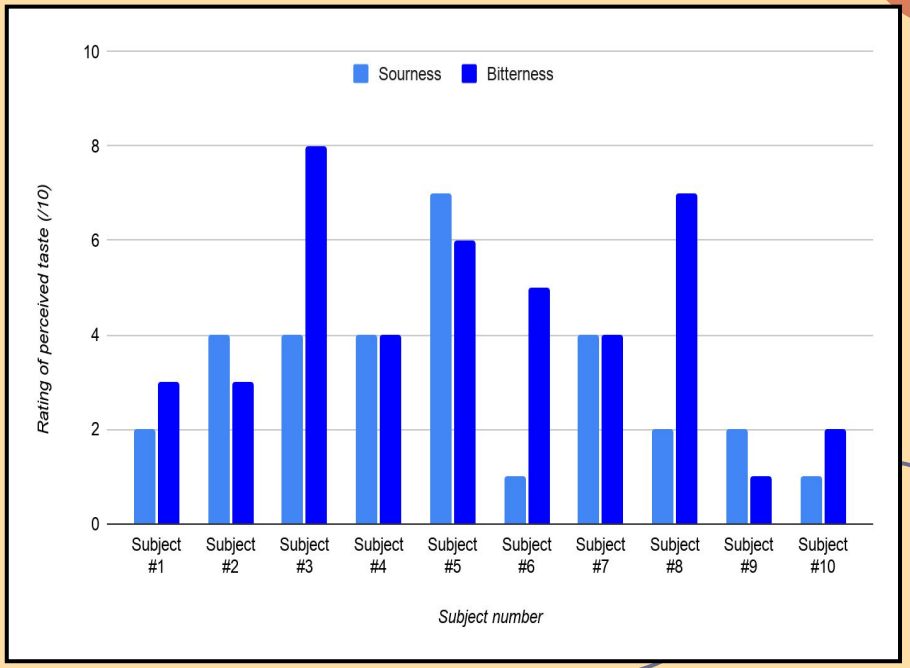


Comparison Between Overall Ratings of the Yellow Beverage & the Control

Appendix Log Book (Continued)

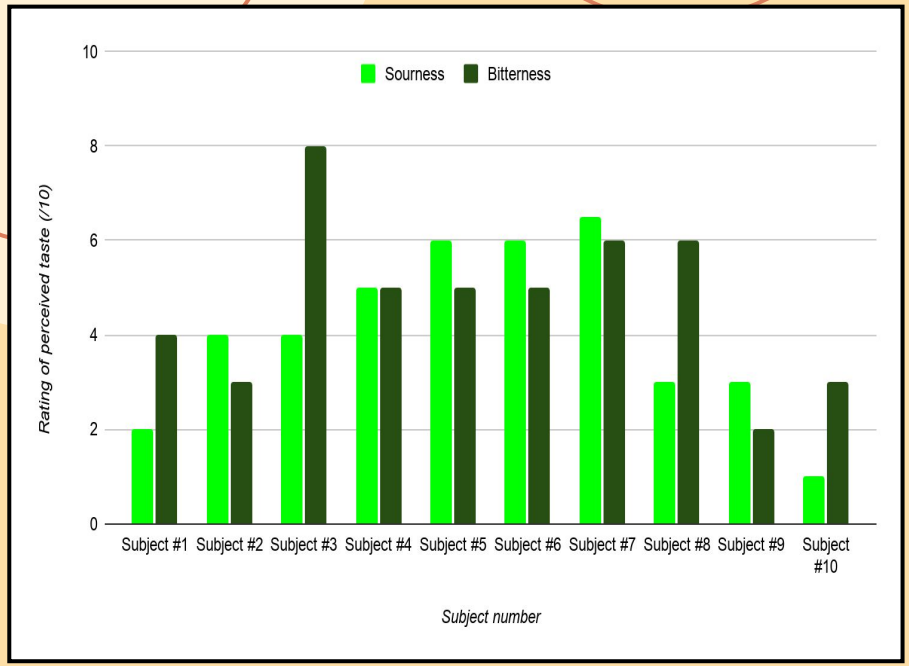


Comparison of Sourness & Bitterness Perception of the Red Beverage

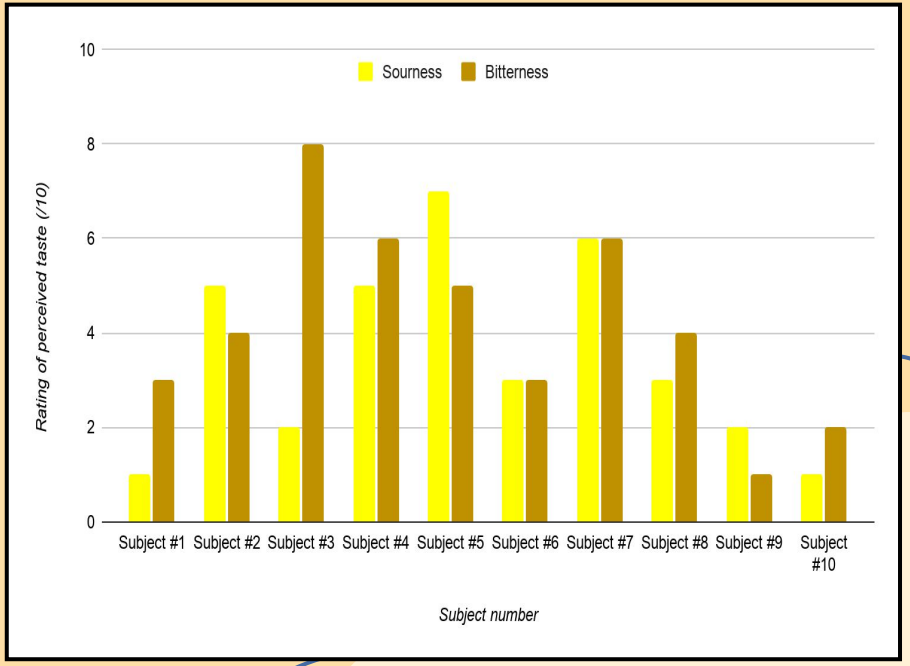


Comparison of Sourness & Bitterness Perception of the Blue Beverage

Appendix Log Book (Continued)



Comparison of Sourness & Bitterness Perception of the Green Beverage



Comparison of Sourness & Bitterness Perception of the Yellow Beverage

The End.