SCIENCE FAIR LOGBOOK

DOES THE METHOD OF STORAGE AFFECT THE VITAMIN C LEVEL OF ORANGES AND IF SO, WHAT METHOD IS MOST EFFECTIVE?

BRAINSTORM: 2025-10-30

Chocolate

Bioremediation of Water

Amount of dye in soda

Water softeners and hard water (we won't actually have to do a titration for this)

How social interactions with AI differ from social interactions with other humans

IF WE CAN USE THE SCHOOL LAB, WE CAN TRY THE AMOUNT OF NUTRIENTS (LIKE VITAMIN C) OR PH OR SUGAR CONCENTRATION IN FRUIT COMPARED TO FRESHNESS OR STORAGE METHOD (TITRATION WITH IODINE I THINK?)

BACKGROUND RESEARCH: 2025-11-01

Methods of storage: Fridge, freezer, counter, cupboard for one week

- Soluble starch (indicator)
- Iodine solution
- Nine oranges – two oranges per storage method, plus one extra as a test orange
- Something to juice the fruit – could probably
- I think it is called Cheesecloth or something like that
- Distilled water
- A volumetric pipette
- Pipette (20 ml should be good?)
- Burette and stand
- Erlenmeyer flasks
- Eye protection
- Heat source

NOTES:

THE COLOUR OF THE JUICE MAY MAKE IT DIFFICULT TO OBSERVE THE COLOUR CHANGE.

IT WILL TAKE A WHILE TO TEST A LOT OF JUICES, BUT WE ONLY HAVE TO MAKE THE STARCH SOLUTION AND IODIDE SOLUTION ONCE SO..... BUT WE HAVE TO BE REALLY CARFUL WITH THE IODIDE SOLUTION (I DON'T KNOW HOW EXPENSIVE THIS WOULD BE) BECAUSE IF THE MOLARITY IS OFF THAN THE WHOLE EXPERIMENT WILL BE BAD.

UNIVERSITY OF CANTERBURY – DETERMINATION OF VITAMIN C CONCENTRATION BY TITRATION

This article details how to determine the vitamin c concentration of a solution using titration in steps like ours

https://www.canterbury.ac.nz/content/dam/uoc-main-site/documents/pdfs/d-other/Determination-of-Vitamin-C-Concentration-by-Titration.pdf -.

ALLRECIPES – HOW TO STORE ORANGES AND KEEP THEM FRESH LONGER

According to this article, oranges last for about a week on the counter, which informed our decision to make the testing period a week long and keep them unwashed. We also decided to keep our oranges frozen while pending a mini experiment to make sure it doesn't explode.

Note: the orange did not explode

https://www.allrecipes.com/article/how-to-store-oranges/

FILLING OUT CYSF PLATFORM: 2025-12-01

Description of experiment:

We will store eight oranges in different environments (2 per storage method), using 1 extra orange to perform a baseline titration. After a week we will juice the oranges and measure their vitamin C content. We will perform a titration using an iodine solution with a soluble starch as an indicator to determine the concentration of vitamin C. We will then evaluate the results to determine if there is a correlation between the methods used to store the oranges and their vitamin C concentration.

FORMULATING PROCEDURE: 2025-12-12

1. Get **two** oranges stored with the same method
2. Juice both oranges together, straining and mixing the juice.
3. Gather orange juice in a clean **20ml** volumetric pipette.
4. Move orange juice into clean Erlenmeyer flask
5. Fill the burette with iodine solution **(0.005M)**
6. Clamp the burette to the burette stand
7. Let the iodine solution through the (twisty thing) to clean it out
8. Add **3 drops** of the starch solution to the orange juice
9. Slowly add the titrant to the orange juice whiles gently swirling the flask
10. Continue until the colour of the juice changes
11. Record volume of iodine used
12. Dispose and clean the Erlenmeyer flask
13. Repeat steps 3-12 for the other 3 titrations
14. Repeat whole experiment for each storage method

HYPOTHESIS AND OBSERVATIONS: 2025-12-15

HYPOTHESIS:

Oranges stored in cold and dark places (such as the fridge/freezer) will preserve more vitamin C compared to warm environments (like the counter) because low temperatures tend to slow down or interrupt natural processes, thereby preventing the natural release of vitamin C over time.

OBSERVATIONS:

- 45.9 titration 1; sunlight 3 drops of starch
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  - Dark: Added iodine before on other titrations = brown / added dark titration 1 = green for a short moment
  - Titration 1 for freezer = white bubbles / froth oozing out when squeezing orange
  - Juice squirting out sides when orange squeezed for freezer orange / skin is permeable
  - Titration 1 for freezer = after adding iodine the mixing a little, added starch and drop point turned blue for short moment
  - Titration 1 for freezer = less pulp / structurally weak
  - DID NOT DRY / CLEAN FLASK AFTER EVERY TRIAL FOR SAKE OF TIME
  - Titration 2 for freezer = after adding iodine the mixing a little, added starch and drop point turned blue for short moment
  - Beaker rinsed out after every titration trial
  - Granulated cylinder rinsed out after every storage trial

DATA ANALYSIS & GRAPH: 2026-01-04

Procedure (Updated):

1. Get **two** oranges stored with the same method
2. Juice both oranges together, straining and mixing the juice.
3. Gather orange juice in a clean **25ml** graduated cylinder.
4. Move orange juice into clean Erlenmeyer flask
5. Fill the burette with iodine solution **(?M)**
6. Clamp the burette to the burette stand
7. Let the iodine solution through the (twisty thing) to clean it out
8. Add **0.5mL** the titrant to the orange juice whiles gently swirling the flask
9. Add **3 drops** of the starch solution to the orange juice
10. Continue to add titrant until the colour of the juice changes to a murky greenish colour
11. Record volume of iodine used in spread sheet

12. Dispose and clean the Erlenmeyer flask
13. Repeat steps 3-12 for the **2 other** titrations
14. Repeat whole experiment for each storage method

Disclaimer: We did not know the concentration of the iodine solution, so we were unable to calculate the exact amount of vitamin C content for each titration. However, the amount of titrant added correlates directly with the vitamin C amount, so our data is still valid (albeit imprecise).

Analysis: In our results, the oranges that required the greatest amount of titrant were the ones that were ***frozen***, meaning they had the ***highest*** vitamin C content. The oranges with the least amount of titrant were the ones stored ***on the counter***, so they had the ***lowest*** vitamin C content. The oranges with the second highest amount of titrant/vitamin C were the ones stored in the ***fridge,*** followed by the oranges stored in the ***cabinet.*** Our hypothesis of the oranges being stored in colder, darker places has been proved correct – on the counter, the oranges received natural sunlight, making it the warmest and brightest environment. These factors – temperature and light – apparently had an impact on the vitamin C concentration in each orange. The most effective storage method in preserving vitamin C in oranges was the ***freezer***. Our experiment concludes that storing your oranges in the fridge not only maintains their taste but also their nutrients levels.

ON COUNTER

	Iodine (Start)	**Iodine (End)**	**Titrant (mL)**	***Average***
Titration 1	45.9	47.9	2.0	*1.50*
Titration 2	44.15	45.5	1.4	
Titration 3	45.45	47.1	1.7	
Titration 4	47.4	48.9	1.5	

IN FREEZER

	Iodine (Start)	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
Titration 1	39.6	41.4	1.8	
Titration 2	41.4	43.5	2.1	*2.02*
Titration 3	43.35	45.5	2.2	

IN FRIDGE

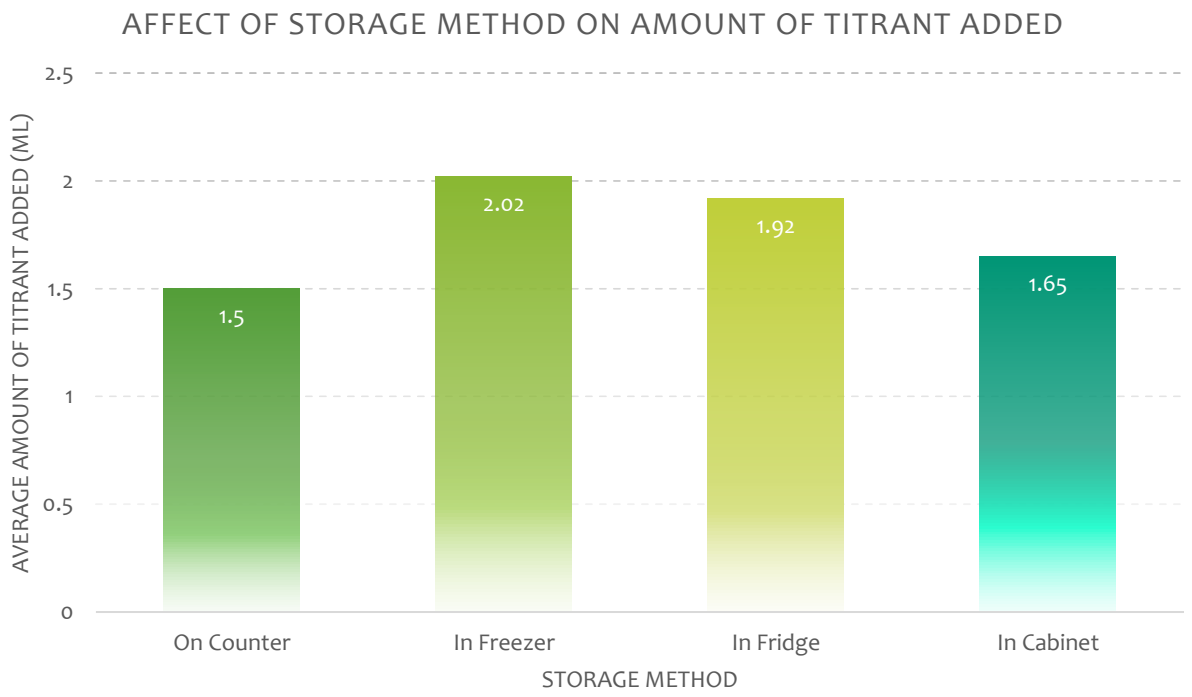
	Iodine (Start)	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
Titration 1	43.4	45.5	2.1	
Titration 2	45.5	47.4	1.9	*1.92*
Titration 3	45.5	47.25	1.8	

IN CABINET

	Iodine (Start)	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
Titration 1	44.8	46.3	1.5	
Titration 2	46.3	48.1	1.8	*1.65*

Titration 3	41.7	43.35	1.7

GRAPH



MEGA TABLE

Storage Method	**Results**				
On Counter:		**Iodine (Start)**	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
	Titration 1	45.9	47.9	2.0	1.50
	Titration 2	44.15	45.5	1.4	
	Titration 3	45.45	47.1	1.7	
	Titration 4	47.4	48.9	1.5	
In Cabinet:		**Iodine (Start)**	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
	Titration 1	44.8	46.3	1.5	1.65
	Titration 2	46.3	48.1	1.8	
	Titration 3	41.7	43.35	1.7	
In Fridge:		**Iodine (Start)**	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
	Titration 1	43.4	45.5	2.1	1.92
	Titration 2	45.5	47.4	1.9	
	Titration 3	45.5	47.25	1.8	
In Freezer:		**Iodine (Start)**	**Iodine (End)**	**Titrant (mL)**	***Average (mL)***
	Titration 1	39.6	41.4	1.8	2.02

Titration 2	41.4	43.5	2.1
Titration 3	43.35	45.5	2.2

POSSIBLE SOURCES OF ERROR

- Mismeasurement
- Different amounts of starch solution

UPDATING INFORMATION: 2026-01-04

IMPORTANCE OF VITAMIN C:

- Antioxidant: helps to prevent damage to cells
- Needed to create collagen
- Collagen: a strong but flexible protein, which is in skin, bones, cartilage and is needed to help wounds heal
- Improves iron absorption
- Helps immune system work
- **MAY** help lower you risk for some cancers
- To little vitamin C cause scurvy

Scurvy Symptoms:

  - Weakened connective tissues
  - Petechiae (red dots on skin)
  - Joint pain
  - Poor wound healing
  - Hyperkeratosis (thickening of the skin)
  - Corkscrew hairs
  - Death

https://ods.od.nih.gov/factsheets/VitaminC-Consumer/

https://ods.od.nih.gov/factsheets/VitaminC-HealthProfessional/

MORE SOURCES OF ERROR:

- The data from the first titration for counter-stored oranges is an outlier
- Amount of starch solution added sometimes changed due to human error
- Concentration of iodine solution was unknown
- Although there was supposed to be a control orange, our control orange was compromised and was no longer a valid control. Could not get a new orange for control for the sake of time
- In transporting the oranges from their testing environments to the lab, changes in temperature/light during the journey may have altered the results
- We did the experiment during the winter so there naturally less light for the orange stored on the counter

DETERMINING VARIABLES:

MANIPULATED VARIABLE: Way the oranges were stored

RESPONDING VARIABLE: Amount of titrant needed to change the colour (correlates to the amount of vitamin C)

CONTROL VARIABLES: Concentration of iodine, amount of orange juice used, amount of indicator (starch solution), colour following titration, amount of time oranges were stored for, amount of oranges per storage technique

IDENTIFY AREAS FOR IMPROVEMENT:

- Obtaining iodine that we knew the concentration of would have allowed us to calculate the exact concentration of vitamin C in each orange, giving us more accurate results than only comparing the amount of titrant used
- Storing the oranges in the lab—rather than keeping the oranges at home and then transporting them to the lab—would have limited unwanted variables and made the data more accurate
- Having a control would have provided a frame of reference for the rest of the results

REAL WORLD IMPACT:

In researching more effective ways to store our food, we equip society to solve the issue of world hunger. Learning better methods for preserving the nutrients in food will aid society in combatting malnutrition. Balancing longer lasting food with higher nutritional content means that less food will be able to go a long way. Researching oranges is only the first step toward further innovation in the food industry; down the line, our findings may play a role in developing more sustainable strategies for food storage.

On a smaller scale, our research is applicable in a low-risk context as well. Temperature and lighting conditions have a direct impact on the nutritional content of vitamin C in oranges. Applying this straightforward knowledge in how we do something as simple as storing groceries may also contribute to a more sustainable food future.

TEMPERATURES OF AREAS:

Counter: 22.2 C (without sunlight)

Cabinet: 19.4 C

Fridge: 2.7 C

Freezer: –16.9 C

TITRATION EXPLAINED

In a titration, stoichiometry is used to determine the amount of a certain reactant. Reactions occur in a ratio known as the molar ratio. In quantitative reactions, the molar ratio is used to determine the amount of moles of a reactant to determine the amount of another chemical agent. The idea of a titration is that using a known concentration and a known volume of reactant A and seeing how much of it is needed to complete a reaction with a known volume but unknown concentration of reactant B, the amount of moles of reactant A needed to

reactant with that volume of reactant B can be determined. Then, using the balanced reaction to derive the molar ratio, calculate the amount of moles of reactant B and, using the volume, the concentration. For this to work, the moment when the reaction is complete (no reactant B left) must be known. By adding an indicator that will either indicate a change in pH or began reacting with reactant A after reactant B is gone creating a compound with a visible colour this moment can be identified. In our experiment, we used soluble starch as an indicator and iodine as a titrant (reactant A). The iodine began to react with the starch after all the vitamin C was consumed creating a purplish-blue that looked green in orange juice. Sadly, we were not able to know the concentration of iodine, so we were unable to calculate the concentration of the vitamin C. However, the amount of iodine used would correlate to the amount of vitamin C so we could still compare the differences.

POTENTIAL REASONS FOR RESULT: 2026-02-21

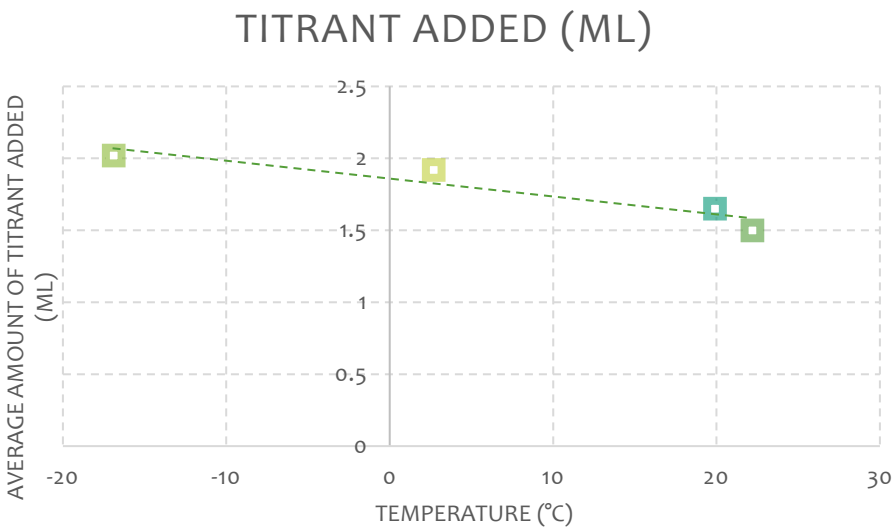
Vitamin C is a particularly unstable nutrient. It degrades in the presence of oxygen, light, high temperatures, and higher pH into dehydroascorbic acid. The dehydroascorbic acid further irreversibly reacts with water creating a different compound. The behavior of vitamin C is unpredictable as the effects of certain antioxidants may either increase or decrease the speed at which the vitamin C degrades. Some studies have even shown that some compounds may increase the speed of the conversion of dehydroascorbic acid to ascorbic acid, effectively stabilizing the amount of vitamin c. Oranges are a complex mix of compounds that have unknown effects on the degradation of vitamin C. This means that the actual reaction that occurs during the degradation of vitamin C within an orange is unclear. Since we cannot be certain about the reaction that is occurring and why, the EXACT reasons that removing light and lowering the temperature slow degradation of vitamin C cannot be fully explained. We can, however, claim that the removal of light and lowering of temperature will slow down any reaction. This means that ANY reactions that either increase or decrease the amount of vitamin C will be slowed down, effectively stabilizing the amount of vitamin C within the orange.

https://b.web.umkc.edu/beckerb/publications/chapters/trans_resp.pdf

https://www.loseit.com/articles/how-do-fruits-and-vegetables-lose-their-nutrients-after-picking/

https://pmc.ncbi.nlm.nih.gov/articles/PMC8773188/#notes3

TEMPERATURE GRAPH: 2026-01-29


TITRANT ADDED (ML)
AVERAGE AMOUNT OF TITRANT ADDED (ML)
2.5
2
1.5
1
0.5
0
-20
-10
0
10
20
30
TEMPERATURE (°C)