TED ANKARA COLLEGE PRIVATE HIGH SCHOOL

CHEMISTRY INTERNAL ASSESMENT

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**Research Question:** “HOW DOES TIME AFFECT THE PRESENCE OF ASCORBIC ACID IN FRESHLY SQUEEZED ORANGE JUICE?

**SECTION A: Introduction:**

Juice is a beverage made from the extraction or pressing out of the natural [liquid](https://www.wikizero.com/en/Liquid) contained in [fruit](https://www.wikizero.com/en/Fruit) and [vegetables](https://www.wikizero.com/en/Vegetable). It has various types such as grape juice, applejuice orange juice. This exploration will primely focus on orange juice. Orange juice is an indispensable part of people’s daily routine exactly at breakfast. In orange juice there is an acid which is an very important acid. re many vitamins and minerals which is beneficial to human health. The manufactured orange juice had put in a carton and with the remnants of juice most probably been there gor months or even years after its manufactured process. Therefore, freshly squeezed orange juice must have the highest amount ascorbic acid. The most important molecule inside the orange juice is ascorbic acid (which is known as Vitamin C in the society). Experts recommend vitamin C intake, if a healthy diet and a healthy life is being talked about. In the past history people that always travelling abroad such as in ships Most experts recommend getting vitamin C from a diet high in fruits and vegetables rather than taking [supplements](https://www.webmd.com/food-recipes/dietary-supplements-topic-overview). Fresh-squeezed orange juice or fresh-frozen concentrate is a better pick than ready-to-drink orange juice. The fresh juice contains more active vitamin C. In this exploration I will explore how does the amount of ascorbic acid changes with periodic time intervals.

First of all, around the world all fruits and vegetables contains vitamin C. If we would like to give an example, for these fruits and vegetables we could say oranges strawberries, brocoi and parsley. However, I choose orange juice because it is the most well known fruit which contains vitamin C. Most of the people in the world including me are well aware of the benefits of orange juice and people use it to recover from sickness or being more healthy. I can maket his assumption because my parents are doctors and they encourage me to drink freshly squeezed orange juice more often. This is one of the reasons I am interested in this topic and want to have research on it. The other one is since people are more into packed orange juice are more accessisble and people drink this more. Since this packed orange juice are less healthy and even the waited orange juice has less ascorbic acid I cannot help wonder why people are consuming packed orange juice. It is a fact that the ascorbic acid level depends on the quality of the juice and we can determinate the ascorbic acid titrating with an oxidant solution. juice since alsoI mentioned “freshly” squeezed orange juice because my mom thought me if I drink the orange juice immediately after she squeezed it then I will have more vitamin c in to my body instead of letting the juice waiting for me to drink for a while. Therefore I am interested in to know more about ascorbic acid’s presence over time intervals in freshly squeezed orange juice. In this exploration I will explore how does the amount of ascorbic acid changes with periodic time intervals.

    Vitamin C is essential to life as it aids in the absorption of iron in the body.  Iron is essential for the transportation of oxygen throughout the bloodstream and helps maintain strong bones, teeth, and connective tissue.  Vitamin C can also reduce the risk of some cancers from developing and tumors from spreading.  In fact, after cancer surgery, vitamin C can be used as part of the patient’s treatment.  People with diets lacking in vitamin C are susceptible to disease.

**SECTION B BACKGROUND INFORMATION:**

In this experiment the vitamin C content in varying periodic time intervals of orange juice will be measured through titration. In this experiment the period of the titraton process was every 2 hours. This means that in every two hours the titration process will be repeated and the vitamin C (ascorbic acid) will be titrated periodically.

Reaction that takes place while titrating freshly squeezed orange juice is on below:

C6H8O6 (aq) + I2 (aq) C6H6O6 (aq) + 2 I- (aq) + 2 H+ (aq)

This reaction equation is in balance so it does not have to be balanced again.

Before the reaction on above in order to maintain iodine (the following reaction did took place;

This symbolic reaction shows that 1 mole of ascorbic acid (which is known as Vitamin C) in liquid phase reacts with 1 mole of iodine (I2) solution, at the products side one mole of dehydroascorbic acid, two moles of iodine anions and two moles of hydrogen cations which both reactants and products which both reactant part and he product part are found dissolved in water (which means aqueous solution) (found/being/ present) .

“Titration” Meaning: Titration is the technique which/ that takes place when there is a solution of unknown concentration is reacted with a different solution which it’s concentration is known. In this experiment “redox” (reduction oxidation reaction) will be used. The solution which has the known quantities is called “titrant” is being dripped down the acid burette (also known as 50 ml burette) to the beaker which has unknown solution concentration. The solution which concentration is known is called “titrant” and the other substance which the concentration is unknown is called as “analyte”. The fact that in a reaction “ascorbic acid is a reducing agent should be taken in attention. This also means that ascorbic acid is oxidized to /as dehydroascorbic acid in the following reaction.

**Figure 1: Air-Oxidation of Ascorbic Acid**



It is an important information to know the volume of “titrant” added is cruicial for the determination of the concentration of the unknown solution. In mostly an “indictor” is being used in order to remark that the reaction inside the burette has reached its “endpoint”.

***Hypothesis:*** *The concentration of ascorbic acid( vitamin C) will gradually decrease over time periods. There will be a sharp decrease in the presence (concentration) of ascorbic acid when it is compared to the time when it was firstly fresh squeezed. I consider that the decrease in the concentration of ascorbic acid will occur very rapidly due to the ready reactants strolling around in the air. Due to ascorbic acid’s reactivity causes “air oxidation” of ascorbic acid. Which is shown at the figure below:*

***VARIABLES:***

*Table: Variables in the experiment*

|  |  |  |
| --- | --- | --- |
| *Independent Variable* | *Dependent**Variable* | *Controlled**Variable* |
| *Vitamin C concentration present in the titration solution* | *Volume of iodine (I2) solution used in titrating fresh orange juice* | *Volume of iodine solution used in each graduated cylinder* |
| *Dehydroascorbic (Oxidized Vitamin C) acid present in the titration solution* |  | *Temperature* |

|  |  |  |
| --- | --- | --- |
| *Time intervals between the measuring of the trials. (120 minutes)* |  | *Concentration of starch solution used* |
|  |  | *Volume of deionized water used (100mL)* |

 *In Table there should be variables which shows the characteristics of the experiment. There should be a mentioning of independent, dependent*

*Also, the reactivity of acids in general is relatively high compared to elements or molecules in the air. Acids have cations or anions at their molecular structure can be shown as the reason why the ascorbic acid concentration is / can be decreasing rapidly over time. Anions and cations have instability due to their free electrons or electron absence. In nature an ion always wants to complete its octet or doublet. The reason why free hydrogen (H+) ions make bonds with acids. For instance, “air-oxidation” reaction takes place when freshly squeezed orange juice left without any barrier that divides the solution with air.*

**Table 1: Lab Materials and their Uncertainties (**Lab equipments required for the “titration of ascorbic acid in freshly squeezed orange juice):

|  |  |  |
| --- | --- | --- |
|  | MATERIALS | UNCERTAINTY |
| 1. | 600 mL beaker | ± 1mL |
| 2. | 250 mL Erlenmayer flask | ± 2.5 mL |
| 3. | 10 mL pipette | ± 0.01 mL |
| 4. | 10 mL graduated cylinder | ± 0.02 mL |
| 5. | 50 mL acid burette | ± 0.05 mL |
| 6. | 1000 mL glass beaker | ±5 mL |

This table is an essential table for the analysis of lab equipment. It is important to take care of the lab equipment’s uncertainties. This will create more concluded and more professional lab report*.*

***METHODOLOGY (INSTRUCTIONS OF THE EXPERIMENT):***

1. Squeeze 1000 mL orange juice. Pour the squeezed orange juice into the 1000 mL (±5mL) beaker.
2. Pour 50 mL (I2) iodine solution into the acid beaker. ( ± 0.05 mL)
3. Put the Erlenmayer flask under the acid beaker.
4. For getting rid of the impurities inside the orange juice use a cheesecloth. Put the cheesecloth on the 1000 mL (±5 mL) glass beaker and then pour little amounts of freshly squeezed orange juice on the cheesecloth.
5. Measure 100 mL orange juice by 10 mL (± 0.02 mL) graduated cylinder.
6. Put 1.5 mL starch solution with the help of 10 mL (± 0.01 mL) pipette into the Erlenmayer flask where 100 mL (± 1mL) orange juice is present.
7. Add deionized water into the solution until the solution inside the Erlenmayer breaches to 150 mL in the Erlenmayer flask (± 2.5 mL )
8. Begin pouring iodine solution into the Erlenmayer flask by managing the acid burette’s flow rate (slow volume is preffered in order to have the control in hands.)
9. While pouring the iodine solution inside the acid burette (± 0.05) with control, start to shake the Erlenmayer flask in order to observe whether the reaction inside the Erlenmayer Fflask had reached it’s own endpoint.
10. After shaking the solution inside the Erlenmayer had reached it’s end point inside the flash there will be a noticable color change from yellow to light Brown and light Brown.
11. When the solution inside the erlenmayer will turn into a dark Brown color write down the volume of iodine poured into the erlenmayer and then substitute initialvolumefrom final volume in order to find this data.
12. After observing the light Brown color keep shaking the erlenmayer until dark Brown color is being observed. Record down the volume used in order to reach the dark Brown color.
13. Repeat the whole method for every trial.

**Qualitative Data:** When the tapcock was opened slowly the Erlenmayer was being shaken very gently, after approximately five seconds a change of color . After the “light brown” color was seen, the Erlenmayer was again in order to observe “dark brown” color to after dark brown color can be seen also. A color change inside the Erlenmayer from “light brown” to dark brown was seen. which change into light brown color was viewed. After approximately few counted seconds later while the Erlenmayer flask was still being gently shaken the dark brown color in the solution did appeared. The dark brown color observation indicates that the reaction did reach it’s endpoint by turning into dark brown color.

 **Safety Issues**: Lab coats, safety glasses and enclosed footwear must be worn at all times in the laboratory.

**RAW DATA**

Table 2: Volume of I2 (mL) Used for Each Trial of Each Sample Including Initial and Final Readings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of Sample | Trials | Initial Reading(mL ± 0.05) | Final Reading(mL ± 0.05) | Volume of I2 Used(mL ± 0.10) |
| Immediately After the Squeezing Process | Trial 1 | 50.00 | 4.00 | 46.00 |
| Trial 2 | 50.00 | 3.90 | 46.10 |
| Trial 3 | 50.00 | 4.60 | 45.40 |
| Trial 4 | 50.00 | 3.70 | 46.60 |
| Trial 5 | 50.00 | 3.70 | 46.30 |
| After 120 Minutes Passed from Squeezing Process | Trial 1 | 50.00 | 7.80 | 42. 20 |
| Trial 2 | 50.00 | 8.10 | 41.90 |
| Trial 3 | 50.00 | 7.68 | 42.32 |
| Trial 4 | 50.00 | 7.40 | 42.60 |
| Trial 5 | 50.00 | 7.20 | 42.80 |
| After 240 Minutes Passed from Squeezing Process | Trial 1 | 50.00 | 11.50 | 38.50 |
| Trial 2 | 50.00 | 11.70 | 38. 30 |
| Trial 3 | 50.00 | 12.10 | 37.90 |
| Trial 4 | 50.00 | 12.00 | 38.00 |
| Trial 5 | 50.00 | 11.60 | 38.40 |
| After 360 Minutes Passed from Squeezing Process | Trial 1 | 50.00 | 15.60 | 34.40 |
| Trial 2 | 50.00 | 14.80 | 35.20 |
| Trial 3 | 50.00 | 15.40 | 34.60 |
| Trial 4 | 50.00 | 14.90 | 35.10 |
| Trial 5 | 50.00 | 15.50 | 34.50 |
| After 480 Minutes Passed from Squeezing Process | Trial 1 | 50.00 | 19.90 | 30.10 |
| Trial 2 | 50.00 | 20.40 | 29.60 |
| Trial 3 | 50.00 | 20.60 | 29.40 |
| Trial 4 | 50.00 | 20.50 | 29.50 |
| Trial 5 | 50.00 | 20.10 | 29.90 |

This table is a brief summary of measured raw datas.

* It is found that in 1000ml of orange juice there are 132 grams of ascorbic acid.

**PROCESSED DATA:**

***Sample Calculation &Error Propogation of Concentration of Ascorbic Acid:***

1. **Average Volumes of Titrant (I2) found in acid beaker and used in Each Trial:**

In this experiment, the uncertainty of acid beaker must be known which is ±0.05mL.

* At the time when orange juice was freshly squeezed:

$\frac{46.00+ 46.10+45.40+46.60+46.30}{5}$ = 46.08 mL = ±0.05 mL

Absolute uncertainty: $46.00\pm 0.05+46.10 \pm 0.05+45.40\pm 0.05$ + 46.60 ± 0.05+ 46.30 ±0.05 = 46.08 ±0.25 mL

* At the time when 120 minutes passed after squeezing process

$\frac{42.20+41.90+42.32+42.60+42.80}{5}$ = 42.36 mL± 0.05 mL

Absolute Uncertainty: 42.20±0.05+41.90±0.05 +42.32±0.05+ 42.60±0.05+42.80±0.05 =

42.36 mL±0.25 mL

* At the time when 240 minutes passed after squeezing process:

$\frac{38.50+38.30+37.90+38.00+38.40}{5}$ = 38.22 mL± 0.05 mL

Absolute Uncertainty= 38.22 mL± 0.25 mL

* At the time when 360 minutes passed after squuezing process:

$\frac{34.40+35.20+34.60+35.10+34.50}{5}$ = 34.76 mL ± 0.05 mL

Absolute Uncertainty = 34.76 mL ± 0.25 mL

* At the time when 420 minutes passed after squeezing process:

$\frac{30.10+29.60+29.40+29.50+29.90}{5}$ =29.70 mL ±0.05 mL

Absolute Uncertainty = 29.70 mL ± 0.25 Ml

 This table shows an easy and clear table of uncertainties of all trials.

In order to find molarity of ascobic acid the following equation is used;

**Va** $×$**Ma** $×$ **nb = Vb** $×$ **Mb** $×$**na**

**Va**= volume (cm3)of ascorbic acid used (which was titrated) = ? (Unknown)

**Ma** = Concentration of ascorbic acid (M) used =

Molar mass of C₆H₈O₆ = (12.0×6 + 1.0×8 + 16.0×6) g/mol = 176.0 g/mol
No. of moles of C₆H₈O₆ = (132/1000 g) / (176.0 g/mol) = 0.00075 mol
Volume of the solution = 100mL = 0.1L
Molarity of Vitamin C in organic juice = (0.00075 mol) / (0.1 L) = 0.0075 M

**nb**= number of moles of acid in balanced equation for reaction = 1

**Vb**= volume of cm3 of weak base (I2) Used = (Average Volume of Titrant(I2) Used= 0.04608 L

**Mb**= concentration of weak base (I2) used = 0.5 M

**nb**= number of moles of weak base in balanced equation for reaction (I-)= 2

**?** = $\frac{46.08 mL × 0.5 M × 1}{0.0075 M × 2}$ = 1536 mL = 1.53600 L

Uncertainty of Average volume of iodine used in each 5 time trival :

At t=0 (at the time when it was first squeezed) ± 0.05 mL

Table 3: Absolute Uncertainty Table of the Average Volume (in mL)

|  |  |
| --- | --- |
| Time ± 1 minute | Uncertainty ±0.05mL |
| Immediately After the Squeezing Process | 46.08 mL  |
| After 120 Minutes Passed from Squeezing Process | 42.36 mL |
| After 240 Minutes Passed from Squeezing Process | 38.22 mL |
| After 360 Minutes Passed from Squeezing Process | 34.76 mL  |
| After 480 Minutes Passed from Squeezing Process | 29.70 mL  |

**Graphs:**

Graph 1: Amount of Iodine Added Versus Ascorbic Acid Rate:

Graph 2: Titration Graph of a Base



In this graph a base’s titration graph. In this experiment, iodine (I2) weak base was used.

**Improvements**: Instead of iodine solution NaOH solution could be used. This would present more safe values and be a more open to calculation. Because with iodine titration the reaction was balanced already.

Rather than recording the final and initial volumes, number of drops recording could be more efficient for raw data table.

**Limitations:** The most common and obvious limitation of titration experiments is that the end point of the process does not necessarily equal the equivalence point precisely. In other words, looking at the titration curve illustrates that when the solution reaches the equivalence point, the measured variable (e.g., the pH level) drops incredibly quickly. This can make it difficult to determine the exact equivalence point. Determining the equivalence point can also be difficult in some cases because the color changes that represent the end point only occur after the amount of titrant (added solution) has exceeded the amount of the analyte (unknown solution).

## **Accuracy of the Measuring Instruments:**

The accuracy of the glassware used to measure the solutions, such as pipettes and burettes, can also act as a limitation in titration experiments. Although glassware can be calibrated, these calibrations are not always completely accurate. Because of the complexity of the burette's structure, another limitation is the possible existence of an air lock in the burette's stopcock, which can interrupt the flow of the added solution, causing inaccurate results.

## **Uncertainty Value:**

As in almost any experiment, the measurements contain some degree of uncertainty. For example, the pH measurements determined by an electronic pH meter can be ± 0.01 pH, which means they may be as much as one-hundredth of a pH off from the true measurement. The same would be true of the measurements taken with the burette, which may be as much as ± 0.1 milliliter off the true measurement.

## **Other Possible Human Errors:**

Human error can also pose many limitations to a titration experiment. For example, if a sample solution has been left open, a small amount of the solution may have evaporated. If the pipette was not washed with distilled water between measuring the titrate and the analyte, the analyte could be contaminated. Conversely, if the pipette was washed between measuring the two solutions, but not rinsed again with the analyte, a small amount of distilled water could remain, diluting the analyte slightly. Other mistakes, such as using smudged glassware or interpreting a color scale inaccurately, can affect the results of a titration experiment as well.

 **Conclusion & Evaluation:**

 The results of the experiment found to be reliable. Because it conveys the conclusion had been reached in this paper.

 The graph of iodine solution versus rate of ascorbic acid has a rapid decrease due to dehydroxidation of ascorbic acid. The uncertainty calculations were done correctly. (Absolute Error) However, in the graph the error bars could suited to an eye appeal proportion. The error bars did cover all of the graph. This was a situation which was unwanted.

 My research and experiment topic was not related to pH measurements. However, in the topic “acid-base titration” it is an essential and a basic thing to consider and talk about “titration graphs” I decided to put a acid-bace titration graph into my explortaion. The primary principle behind my exploration was “titration”.

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