

***Analytical Chemistry***

***CHEM234***

***Sec 1***

***Unknown: P***

***Exp8: Title***

***Determination of ascorbic acid in vitamin C tablets***

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* **Abstract:**

A redox titration (also known as an oxidation-reduction titration: one of the reactants "reducing agent" loses electrons to another reactant "oxidizing agent") can accurately determine the concentration of an unknown analyte by measuring it against a standardized titrant, similar to an acid-base titration. However, the aims of this experiment are to standardize an oxidizing agent (iodine solution) and use that standardized solution to calculate the quantity of ascorbic acid in a commercial vitamin C tablet. We standardized iodine solution against a main standard arsenic (III) oxide to achieve these objectives. Arsenic (III) oxide is dissolved in base, then neutralized to form arsenious acid. In a buffered solution with sodium bicarbonate, the latter is oxidized by iodine titrant to arsenic acid. The % of ascorbic acid (C6H8O6), which is the reducing agent in the redox titration, was then determined using the standardized iodine solution. When excess iodine solution is added, starch generates a dark blue starch-triiodide complex, which we utilized to identify the endpoint.

As a result, the following were the main reactions that occurred in this experiment:

As2O3(s) + 2OH- + H2O 🡪 2H2AsO3- + 2H+ 🡪 2H3AsO3

I2 + H3AsO3 + H2O 🡪 2I- + H3AsO4 + 2H+

I2 + C6H8O6 🡪 2I- + 2H+ + C6H6O6

The final result of 95% **confidence interval** for unknown (P) = (73.21 ± 0.9813) %, and the final result of 95% **confidence interval** for known = (0.01462 ± 0.0009821)%

**General observations:**

**Did the tablet dissolve completely?** Yes, the table dissolved completely

**Color of the solution before adding starch** indicator was colorless.

**Color of the solution after adding starch** indicator was colorless.

* **Data and results:**
* Mass of arsenic (III) oxide 0.1470 g
* Table\_1: Standardization of Iodine for known sample

|  |  |  |  |
| --- | --- | --- | --- |
|  | Trial #1 | Trial #2 | Trial #3 |
| Initial volume of iodine (mL) | 0.00 | 0.10 | 0.00 |
| Final volume of iodine (mL) | 19.80 | 20.40 | 20.90 |
| Net volume of iodine (mL) | 19.80 | 20.30 | 20.90 |
| Concentration of iodine solution (M) | 0.01501 | 0.01464 | 0.01422 |
| Iodine average volume | 20.30 % |

* For trial 1:
* **Moles of arsenic (III) oxide**
= mass of arsenic oxide/molar mass of arsenic oxide
= 0.1470/197.84 = 7.430 \* 10-4 mole
* **Moles of arsenious acid
= moles of arsenic (III) oxide \*2** = 1.486 \* 10-3 mole.
* **Concentration of arsenious acid**
= moles of arsenious acid/ total volume (100.00 ml)
 = 1.486 \* 10-3 \* 1000/ 100.00 = 0.01486 M.
* **Concentration of iodine solution**
= (concentration of arsenious acid \* volume of aliquot)/volume of iodine solution)
= (0.01486 \* 20.00)/19.80 = 0.01501 M
* **Average concentration of iodine solution:**

= Trial1 +Trial2 + Trial3 / 3
= 0.01462 M

* **Standard deviation of concentration of iodine solution (%):**
(s) =$\frac{\sqrt{\sum\_{}^{}(xi-x(mean))2}}{n-1}$

$=\frac{\sqrt{\left(0.01501-0.01462\right)^{2}}+\left(0.01464-0.01462 \right)^{2}+\left(0.01422-0.01462\right)^{2}}{3-1}=$ 3.953 \* 10-4$ $

**Grubbs test:**Gcalculated = ((questionable value – mean) / (s))
= ((0.01501 – 0.01462) / (3.953 \* 10-4))
= 0.9866
- The suspension value isn’t outlier because the G table > G test
- **The G table** confidence level of 95% & n = 3 = **1.153**

 **0.9866 < 1.153**

* **RSD %:
Coefficient of variation = ((s\x) \* 100)**= (3.953 \* 10-4/ 0.01462) \* 100% = 2.704 %
* **95 % confidence interval(**$ μ)=x\frac{\pm ts}{\sqrt{n}}$
= 0.01462 ± ((4.303 \* 3.953 \* 10-4) / $\sqrt{3}$
= 0.01462 ± 0.0009821
* Mass of vitamin C tablet: 0.6507 g
* Table\_2: Determination of ascorbic acid in vitamin C tablet for unknown sample.

|  |  |  |  |
| --- | --- | --- | --- |
| Unknown: P | Trial #1 | Trial #2 | Trial #3 |
| Initial volume of iodine (mL) | 0.00 mL | 0.00 mL | 0.10 mL |
| Final volume of iodine (mL) | 18.40 mL | 18.60 mL | 18.60 mL |
| Net volume of iodine (mL) | 18.40 mL | 18.60 mL | 18.50 mL |
| Concentration of the ascorbic acid solution | 0.02690 M | 0.02720 M | 0.02705 M |
| Moles of ascorbic acid in 100 ml | 2.690 \* 10-3 mol. | 2.719 \* 10-3 mol | 2.7047 \* 10-3 mol |
| Mass of ascorbic acid | 0.4738 g | 0.4789 g | 0.4764 g |
| Percentage of ascorbic acid in the vitamin C tablet | 72.81 % | 73.60 % | 73.21 % |
| Iodine average volume | 18.50 % |

* **Calculations for trial 1:**
* **Net volume of iodine(ml)**
 = Final volume of iodine (mL) – Initial volume of iodine (mL)
 = 18.40 – 0.00 = 18.40 ml
* **Concentration of the ascorbic acid solution**
 = (concentration of iodine solution\* net volume of iodine)/volume of aliquot) = (0.01462 \*18.40)/10.00 = 0.02690 M
* **Moles of ascorbic acid in 100 ml**
= concentration of ascorbic acid \* total volume
= (0.02690\*100.00)/1000= 2.690 \* 10-3 mol.
* **Mass of ascorbic acid**
= moles of ascorbic acid \* molar mass of ascorbic acid
= 2.690 \* 10-3 \* 176.12 = 0.4738 g
* **Percentage of ascorbic acid in the vitamin C tablet**
= (mass of ascorbic acid/ mass of tablet) \* 100%
= (0.4764/0.6507) \*100% = 72.81 %
* **Standard deviation of percentage of ascorbic acid in the vitamin C tablet (%):**
(s) =$\frac{\sqrt{\sum\_{}^{}(xi-x(mean))2}}{n-1}$
* $=\frac{\sqrt{\left(72.81-73.21\right)^{2}}+\left(73.60-73.21\right)^{2}+\left(73.21-73.21\right)^{2}}{3-1}=$ 0.3950$ $
* **Grubbs test:**Gcalculated = ((questionable value – mean) / (s))
= ((73.60 – 73.21) / (0.3950))
= 0.9873
- The suspension value isn’t outlier because the G table > G test
- **The G table** confidence level of 95% & n = 3 = **1.153
🡪 0.9873 < 1.153**
* **95 % confidence interval(**$ μ)=x\frac{\pm ts}{\sqrt{n}}$
= 73.21 ± ((4.303 \* 0.3950) / $\sqrt{3}$
= 73.21 ± 0.9813
* **Error:**

 ((Theoretical -experimental)/Theoretical) \*100%

= ((650.7 – 473.8 ) / 650.7 ) \* 100%
= 27.19%

* **Discussion and conclusion:**

In the table\_1 the average concentration of iodine solution of 3 trial = 0.01462 M, and the Standard deviation of concentration of iodine = 3.953 \* 10-4

In table\_2 shows that no rejected samples were produced using the 95 percent G-Test that we used on our results in table\_2 of evaluating the unknown sample. As a result, the mean of the three trials' **percentage of ascorbic acid in the vitamin C tablet (%)** is ((72.81 + 73.60 + 73.21) / (3)) = 73.21 percent, with a standard deviation in the percentage **of ascorbic acid in the vitamin C tablet (%)** of 0.9813 percent.

The G test shows whether the values are far from each other or close \* and if the value is more than 1.153 (G table), this means that the value is outlier and should not be taken and if the value is less than 1.153 we take the value because it is true. however, my result was 0.9866 in the known value while unknown my value was 0.9873. The both values are less than 1.153, so they are both true.

The indicator starch was used, which, when the solution reaches the end point of titration, the color of the solution in the flask becomes deep blue (colorless 🡪 deep blue)

The final result of 95% **confidence interval** for unknown = (73.21 ± 0.9813) %

The final result of 95% **confidence interval** for known = 0.01462 ± 0.0009821, the average 0.01560 to 0.01364.

The second part, after adding starch and 10 ml of vitamin C, covered the opening of the flask with a small piece of cardboard with a small opening to enter the burette. It was quickly titrated due to the reduced air oxidation of ascorbic acid, and we proceeded until the color was a tri-starch deep blue.

There are many methodological errors that exist, and one of these common errors is that when the solution is poured into buret in the presence of a glass funnel, it isn’t removed during titration after the required solution has been poured causing an increase in the error rate, because it may be contaminated or otherwise, and it is possible that The buret is contaminated and reading through the buret may be inaccurate. One common error is bubbles in the buret. Finally, these errors should be avoided by paying attention that when filling the burette with the solution, we remove the glass funnel in order to take the reading correctly and that we wash the buret properly.