Finding The Amount Of Oxalic Acid In Rhubarb Leaves By Xiaotong(Lisa)LIU

INTRODUCTION;
Titration is the process of adding a standard solution to a solution with an unknown concentration using a burette. The purpose of Titration is to determine the concentration of the unknown concentration. In Titration a specific volume of the solution with the unknown concentration is usually measured and transferred into a conical flask by using a pipette (it is the aliquot) and an indicator added to it. Then using the burette the standard solution is added and when the solution in the conical flask reaches the endpoint(slight colour change, pH change). The Titre is recorded, this is then repeated multiply times. Concordant Titres are obtained by eliminating outliers in the data. Then the unknown concentration will be worked out via calculation using the average concordant Titre.

AIM;
The aim of this experiment was to measure the amount of Oxalic Acid present in Rhubarb Leaves by using titrating with Sodium hydroxide.

Background Information

Oxalic acid;

Chemical formula; $C_2H_2O_4$ or $(COOH)_2$ or HOOCCOOH (Composed of 2 Carbon atoms, 2 Hydrogen atoms and 4 Oxygen atoms.

Exact mass; 89.995309g/mol (4)

Melting point; 189.5 degrees C (4)

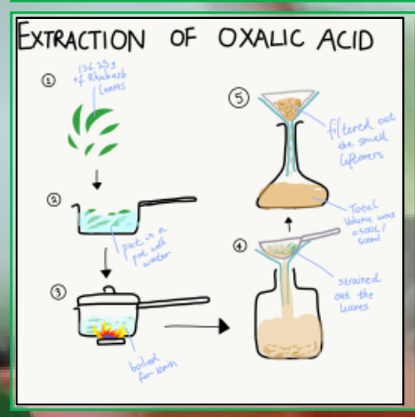
Worded formula of the reaction;
Oxalic acid + Sodium hydroxide → Sodium Oxalate + water

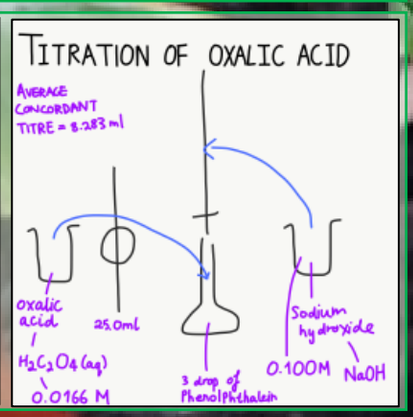
Chemical formula of the reaction;
H2C2O4(aq) + 2 NaOH(aq) → Na2C2O4(aq) + 2 H2O(l)

Information
Oxalic acid is also referred to as Oxalate or ethanedioic acid. It is a toxic organic compound that can be found in leafy greens, fruits, cocoa, nuts and seeds. Generally, within the plants it binds to the minerals, examples are Calcium oxalate and Iron oxalate.

It is usually found in a powder/granular solid at room temperature. Oxalic acid is a colourless, odourless crystalline hydrate. It is also a sublime, it belongs to the family of carboxylic acid. Its crystals have a pyramidal shape characteristic to them. Oxalic acid is sensitive to heat and may react violently with alkali metals. It is potentially explosive when mixed with specific compounds. Its solid is denser than water and it is water soluble. Oxalic acid count as a diprotic acid as it has 2 Hydrogen atoms in its chemical formula.

Oxalic acid can be classified as an antinutrient, in the body it usually binds to minerals in the colon, but this may also occur in the kidney and other parts of the urinary tract, it is then eliminated in the stool or urine. A major health concerns are that it prevents the gut from absorbing the minerals and may contribute to kidney stones.





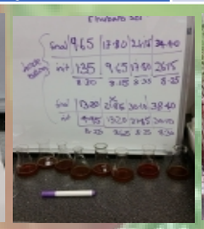
RESULTS;

	Trial 5	Trial 6	Trial 7	Trial 8
Final(ml)	13.20	21.85	30.10	38.40
Initial(ml)	4.95	13.20	21.85	30.10
Titre(ml)	8.25	8.65	8.25	8.30

	Trial 1	Trial 2	Trial 3	Trial 4
Final(ml)	9.65	17.80	26.15	34.40
Initial(ml)	1.35	9.65	17.80	26.15
Titre(ml)	8.30	8.15	8.35	8.25

Note; trial 6 and 1 cannot be used as it is not a concordant titre.

Concordant titres(ml)	8.25, 8.25, 8.25, 8.30,8.30, 8.35
Average titre(ml)	8.283

Calculation of the concentration of the Rhubarb extract:

Step 1; Balanced equation;
H2C2O4(aq) + 2 NaOH(aq) → Na2C2O4(aq) + 2 H2O(l)

Step 2; Identify the unknown chemicals
The known is NaOH as there is 8.283ml and the concentration of 0.100M.
The concentration of $H_2C_2O_4$ is unknown and there is 25ml.

Step 3 Find the mole of the know chemical;
n(2NaOH) = C(NaOH) * V(NaOH)
= 0.100M * 8.283/1000ml
= 0.0008283mol

Step 4 Do a mole ratio between the mole of unknown and moles known.
N of unknown/n of known = coefficient of unknown/coefficient of known
n of unknown/n of known = $n(H_2C_2O_4)/n(NaOH) = 1/2$

Step 5 Rearrange the above ratio
n of unknown = coeff of unknown/coeff of known * n of known
$n(H_2C_2O_4) = 1/2 * (2NaOH)$

Step 6 Substitute the answer from step 2;
$n(H_2C_2O_4) = 1/2 * 0.0008283mol$
= 0.0004142mol

Step 7 Calculate the concentration of the unknown chemical;
Concentration of Oxalic acid = n/volume
= 0.0004142mol/0.025L
= 0.0166 M

Calculate the mass of Oxalic acid in 1L

Step 1 Find the Mr of the Oxalic acid in 1 mol;
$Mr(H_2C_2O_4)$ = 2H+2C+4O
= 2(1.0)+2(12.0)+4(16.0)
= 90.0g/mol

Step 2 Covert the Concentration per Litre into mass per L;
$Mass(H_2C_2O_4)/L = n(H_2C_2O_4)*Mr/L$
= 0.0166M*90.0g/L
= 1.494g/L

Calculate the mass of Oxalic acid in 500ml

Step 1 Convert 1L(1000ml) into 500ml by dividing by 2;
$1.494g/L = 2*mass(H_2C_2O_4)/500ml$
Hence $Mass(H_2C_2O_4)/500ml = 0.747g/500ml$

Calculate the mass of Oxalic acid in 100g of Rhubarb leaves;

Step 1 Use logic ^-^;
500ml of the solution was extracted from 136.25g of Rhubarb leaves hence there should be 0.747g of Oxalic acid in 136.25g of Rhubarb leaves.

Step 2 Convert;
0.747g of $(H_2C_2O_4)$/136.25g of Rhubarb = $mass(H_2C_2O_4)$/100g of Rhubarb
$100*0.747 = 136.25*mass\ of\ (H_2C_2O_4)$
Mass of $(H_2C_2O_4)$ = 0.548g

Hence the mass oxalic acid in 100g of Rhubarb leaves is 0.548g.

Oxalic Acid								
Chemical formula	Molar Mass	Concentration	Mass in 100g of Rhubarb leaves	Mass in 136.25g of Rhubarb leaves	Mass in 500ml of oxalic acid extract	Mass in 1L of oxalic acid extract	Aliquot	Total volume of the extract
$C_2H_2O_4$	90g/mol	0.0166 M	0.548g	136.25	0.0747g	1.494g	25.00ml	500ml/0.50L

Sodium Hydroxide				
Chemical formula	Molar Mass	Concentration	Structural formula	Average Titre
NaOH	40g/mol	0.100M	Na–O–H	8.283ml

Errors and Improvements

There are serval errors present in the process of this experiment. A major systematic error is the colour of the aliquot, the solution remained yellow after being extracted from the rhubarb leaves. This impacted the accuracy of the Titre as the endpoint is based on seeing a slight colour change and the brown colouring made it difficult to detect. Which means the titre's value might be slightly over.

Another concern regarding to the detection of the endpoint are the random errors, the slight colour changes are based on human sight and perspective Hence there might be slight inaccuracies present in the data collected. In addition, the titration was done in two different time periods, this means that the results might be impacted by the different environments, for example different lighting may cause the eye to perceive colours slightly differently.

Overall there will be several other slight random errors present and because all procedures were done by a human hence observational errors when measuring the solutions must also be accounted for.

Various changes can be made to the experiment to improve it. First of addressing the colour of the extract, if there is a method to ensure that the colour of the extract is clear, it will greatly increase the accountability of the results. It is also important to ensure that the environment stays the same when titrating, do all the trials in one go. Random observational errors are hard to avoid however ensure that the values are as accurate as possible in each step by implementing strategies such as double checking all the measurements before recording it and using half drops to titrate when the solution is close to reaching the endpoint. The amount of trials in this experiment was sufficient, it clearly allowed the outliers to be detected but adding more trials would make the final result more accurate.

CONCLUSION

As the results show, there are 0.548g of Oxalic acid present in per 100g of Rhubarb leaves. This means that the aim of the experiment had been reached, the experiment successfully measured the amount of Oxalic Acid present in Rhubarb leaves by titrating with Sodium hydroxide. However, there were serval systematic errors and random errors that were made in the experiment hence there are various improvements that can be made to ensure that the final data would be more reliable.

Glossary
Titration – Titration is a process/technique where a solution with a known concentration is added to a solution with an unknown concentration to find the unknown concentration.
Aliquot – A known volume delivered from the Pipette
Standard solution – A standard solution is a solution with a known volume.
Endpoint – The endpoint is when the indicator experience a slight colour change and it is when titrating stops.
Titres - A Titre is the volume from a burette.
Concordant tires – Concordant tires and tires that from the top value to the bottom value is within a certain range. In this experiment the range is determined to be 0.10ml.
Burette – A burette is the device used for titrating, it has units on its side and allow the titre to be measured.
Pipette – A pipette is an instrument that can accurately measure a defined volume. The purpose of the pipette is to deliver that volume into another vessel.
Concentration – Concentration is the amount of particles in a volume.
Indicators – An indicator is a chemical that changes (slightly) formula in different pHs resulting in different colours.
Sample – A small volume taken from the initial solution; it retains the same concentration as the original solution.
Mole – The mole is a counting system for chemist, it is also Avogadro's number (a.k.a. $6.02*10^{23}$) and counts the number of particles.
Molar Mass (MR) – The Molar mass is the mass(g) of a one mole of a particular element, molecule or compound.

Referencing + Bibliography for the background research of Oxalic acid ^-^

- Spritzler, F. (2017). Oxalate(Oxalic Acid) : Good or Bad?. Retrieved from https://www.healthline.com/nutrition/oxalate-good-or-bad
- The Editor of Encyclopedia Britannica. (n.d.). Oxalic Acid. Retrieved from https://www.britannica.com/science/oxalic-acid
- Cheprasov, A. (n.d.). Oxalic Acid : Structure, Formula & Uses. Retrieved from https://study.com/academy/lesson/oxalic-acid-structure-formula-uses.html
- Pub Chem. (n.d.). Compound Summary Oxalic Acid. Retrieved from https://pubchem.ncbi.nlm.nih.gov/compound/Oxalic-acid#section=Fire-Hazards
- Chemistry 111 Lab. (2005). ACID-BASE TITRATION Form A The Molar Mass of an Unknown, Diprotic Acid. Retrieved from http://employees.oneonta.edu/viningwj/Chem111Labs/Acid_Base.pdf
- Bodner Research Web. (n.d.). Diprotic and Triprotic Acids and Bases, Retrieved from https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch17/diprotic.php#acid