Investigation of the effect of different kinds of citrus fruit juices on kidney stones (calcium oxalate)

Research Question:

How do different kinds of citrus fruit juices affect kidney stones (calcium oxalate) which is determined by mixing 0.1 mol.dm^{-3} of calcium nitrate and 0.1 mol.dm^{-3} of sodium oxalate solutions, adding a few drops of fruit juices, filtering, drying and weighing the precipitate (calcium oxalate)

Subject : Chemistry
Word Count: 3965

1.Introduction

As you know thousands of people suffer from kidney stones to put it in a numerical perspective, around half million people go to the emergency rooms suffering from kidney stones, and treating these kidney stones can warry from 7000 to 10000 dollars, so kidney stones affect your financial status and your body health, so you should do everything you can to prevent such disease, but let's say for some reason you weren't able to prevent this disease and you found out its a minor kidney stone, my research is about this, new studies show that small doses of citric acid prevents kidney stone formation and can even dissolve some of the smaller ones in certain circumstances, and if my hypotheses are true, some of the kidney stones can be cured with consumption of citrus fruits. In this experiment I will be testing if citric acid in citrus fruits will actually help dissolving kidney stones, and according to the results of my study I might actually prove alternate ways to get rid of kidney stones without the need of an operation that will harm you economically and physically.

2.Background information

2.1 Kidney Stones

Kidney stones, also known as urolithiasis, occur when solids develop in the urinary tract. Kidney stones are usually formed in the kidneys and are excreted from the body in the flow of urine. Small stones can pass through without causing any symptoms. When stones grow beyond 5 millimeters (0.2 inches), they can cause obstruction of the ureter and cause sharp and severe pain in the lower back and abdomen. Stones can also cause hematuria, vomiting, or painful urination. About half of people who have kidney stones will have another kidney stone within 10 years. Most stones are formed by a combination of genetic and environmental factors. Risk factors include high levels of calcium in the urine, obesity, certain foods, some medications, calcium supplements, hyperparathyroidism, gout, and not drinking enough water. High levels of minerals in the urine form stones in the kidneys. Diagnosis is usually based on symptoms, urinalysis, and medical imaging. Blood tests are also useful. Stones are usually categorized by location: kidney stones (intrarenal), urinary calculi (in urinary tract), bladder stones (intravesicle), or what they are made up of (calcium oxalate, uric acid, struvite, cystine).

Stone disease is prevented by drinking enough fluid to produce more than 2 liters of urine a day. If this does not work well, you can take thiazide diuretics, citrates, or allopurinol. It is advisable to avoid soft drinks containing phosphoric acid (usually cola). If the stone does not cause symptoms, no treatment is needed. Otherwise, pain management is usually the first action with drugs such as nonsteroidal anti-inflammatory drugs and opioids. Larger stones can be removed with tamsulosin medicine. Alternatively, procedures such as extracorporeal shock wave lithotomy, ureteroscopy, or percutaneous nephrtomy may be required. 1% to 15% of people around the world are affected by kidney stones at some point in their lives. In 2015, there were 22.1 million cases and about 16,100 deaths. They have become more common in Western countries since the 1970s. In general, men are more affected than women. Kidney stones have afflicted people throughout history with a description of surgery to remove them, dating back to 600 BC.

2.1.1 Chemical Composition of Kidney stones

Kidney stones are usually separated into 4 groups: *Calcium Stones*, *Struvite stones*, *Uric acid Stones* and *Cystine Stones.* However, Calcium Stones are the most regular type of kidney stones that is encountered during diagnosis so Calcium Stones in this experiment are more viable. Calcium oxalate (CaC_2O_4) is made up of sodium oxalate ($Na_2C_2O_4$) and Calcium Nitrate ($Ca(NO_3)_2$), and the reaction for this is;

$Na_2C_2O_4(aq) + Ca(NO_3)_2(aq) \rightarrow CaC_2O_4(s) + NaNO_3(aq)$

2.1.2 How Does Kidney Stones Form

Kidney stones form when your urine contains more crystal-forming substances such as calcium, oxalate and uric acid than the fluid in your urine can dilute. At the same time, your urine may lack substances that prevent crystals from sticking together, creating an ideal environment for kidney stones to form.

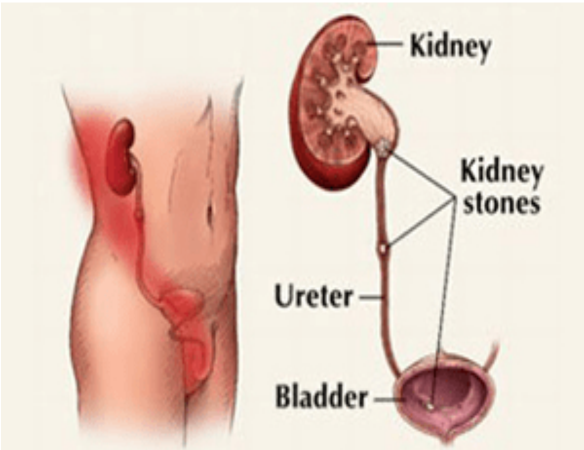


Figure 1.1 Position of kidney stones in urinary canal

The crystalization can ocur in kidney then it can be passed through urinary canal. We see that kidney stones are formed in the kidneys when the calcium rich urine is tried to be filtered, then its passed down to the urinary canal causing extreme pain and problem properly filtering the urine and discarding the urine.

2.1.3 Kidney Stone Treatment Procedure

An urologist can use the following procedure to remove or break a kidney stone into small pieces:

i. Shock wave lithotripsy.

Doctors can use NIH externally coupled shock wave lithotripsy to blow up kidney stones into small pieces. Smaller pieces of kidney stones pass through the urinary tract. Your doctor may provide anesthesia during this outpatient procedure.

ii. Cystoscopy and ureteroscopy.

During a cystoscopy, doctors use a cystoscope to look inside the urethra and bladder to look for stones in the urethra or bladder. During ureteroscopy, doctors use a ureteroscope that is longer and thinner than a cystoscope to view detailed images of the ureters and the lining of the kidneys. Doctors insert a cystoscope or ureteroscope through the urethra to view the rest of the urinary tract. Once a stone is found, the doctor can remove it or break it into smaller pieces. Doctors perform these procedures in a hospital with anesthesia. You can usually go home on the same day.

iii. Percutaneous nephrolithiasis.

Doctors use a thin viewing instrument called a nephroscope to find and remove kidney stones. Doctors insert the instrument directly into the kidney through a small incision in the back. For larger kidney stones, your doctor may also use a laser to break the kidney stones into smaller pieces. Doctors perform external Nephrolomy NIH external links from hospitals as anesthesia. You may need to stay in the hospital within a few days after the procedure is over.

2.2 Citrus Fruits and Citric Acid

In this experiment I will be using citrus fruits, so in this background information I will be explaining the chemical composition and the enzymes that work on the breakdown process of Calcium Oxalate (Kidney Stone). The citrus fruits that were used in this experiment are, Grapefruit (*Citrus Paradisi)*, Orange (Citrus Sinensis), Mandarin (*Citrus Reticulata*), Lemon (*Citrus Limon)*, and as a personal addition to the hypothesis, I used vinegar (Acetic acid). Starting off with the chemical composition of the fruits. The main dissolvent that these fruits has is Citric Acid ($C_6H_8O_7$), citric acid is a relatively strong weak acid, the pH of citric acid in 0.033 M citric acid is around 2.2, a pH which is only a little higher than lemon when its created in a laboratory environment, other than citric acid, there is also an acid called Ascorbic acid

($C_6H_8O_6$), in other words Vitamin C even though this acid is not corrosive or it can act as a catalyst in dissolving process.

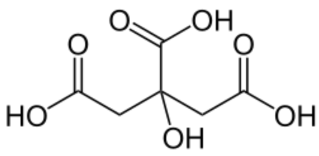


Figure 1.2 Citric Acid

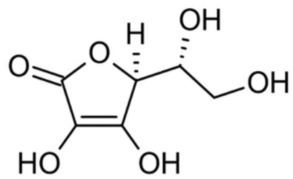


Figure 1.3. Ascorbic Acid

There is also an enzyme called Glutamic acid decarboxylase (GAD) that is the crucial enzyme involved in the synthesis of gamma-aminobutyric acid (GABA), a major neurotransmitter of the central nervous system (CNS). In the presence of pyridoxal 5′-phosphate (PLP) as cofactor, GAD catalyzes the irreversible alpha decarboxylation of l-glutamic acid to yield GABA and CO_2, this reaction causes to carbon dioxide levels to increase and causes the acidity to increase. All the components are the main factor at dissolving kidney stones.

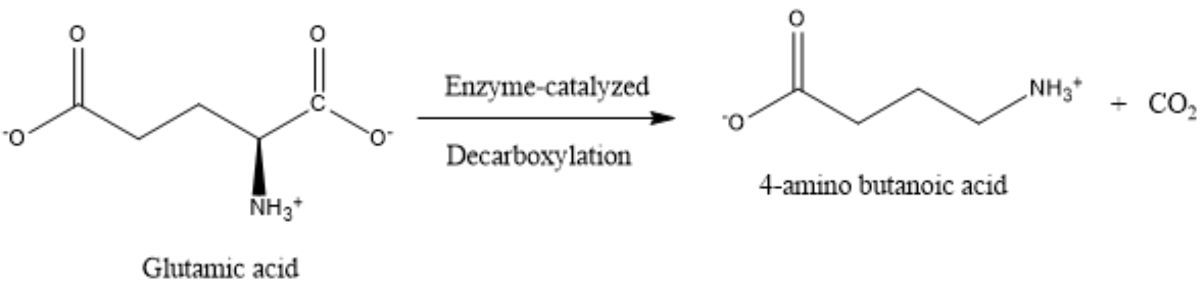


Figure 1.4. Reaction of GAD resulting in carbon dioxide production.

The substance that is going to be used as kidney stone is Calcium Oxalate, Calcium Oxalate is 98% of the actual kidney stones, so we can analyze effects of citrus fruits better in this chemical compound.

2.3 Solubility Equilibrium and Treatment of Kidney Stones by Citrus Fruits

The solubility equilibrium is a type of dynamic equilibrium when the compound in the solid state is at equilibrium with its solution so that their dissolution and sedimentation rates are equal to each other. When equilibrium is achieved, the solution is said to be saturated. The concentration of a solute in a saturated solution is called solubility. Solubility can be expressed in moles ($mol.dm^{-3}$) or mass per unit volume (eg $\mu g\ ml^{-1}$). Solubility depends on the temperature. A solution containing a concentration of solute higher than its solubility is said to be supersaturated. A supersaturated solution can be equilibrated by adding "seeds" that can be small solid particles or small solute crystals that initiate precipitation. Equilibrium solubility is important in pharmaceutical, environmental and drainage of other scenarios.

The pH of an aqueous solution can affect the solubility of the solute. Changing the pH of a solution can change the charge state of the solute. If the pH of a solution is such that certain molecules do not carry a net charge, then the solute often has minimal solubility and precipitates out of solution.

3.Research Question

How do different kinds of citrus fruit juices affect kidney stones (calcium oxalate) which is determined by mixing 0.1 $mol.dm^{-3}$ of calcium nitrate and 0.1 $mol.dm^{-3}$ of sodium oxalate solutions, adding a few drops of fruit juices, filtering, drying and weighing the precipitate (calcium oxalate).

4.Method

4.1. Hypothesis

Kidney Stones need to face a lower pH value in the mixture to disintegrate, and for that to happen in the experiment I believe fruits with lower pH values like lemon, vinegar and grape fruit will have less residue on the filter paper after precipitation of calcium oxalate is completed. Grapefruit, lemon and vinegar will have less Calcium Oxalate residue left on the filter paper at the end of the drying process, while orange and mandarin will have more residue beacause they have more alkaline pH values.

4.2. Variables

4.2.1 Dependent Variable

- Mass of Calcium Oxalate left in the filter paper after adition of different citrus fruits in grams.

4.2.2 Independent Variable

- Types of citrus fruit juices used in the experiment (Grapefruit (*Citrus Paradisi)*, Orange (Citrus Sinensis), Mandarin (*Citrus Reticulata*), Lemon (*Citrus Limon)*, and as a personal addition to the hypothesis, I used vinegar (Acetic acid).) These variables are chosen because reduction in formation of Calcium Oxalate can be observed best under less acidic fruits and more acidic fruits. Mandarin being the least and acetic acid being the most acidic.

4.2.3 Uncontrolled Variables

- Residue that was left on the knife while cutting the fruits
- Any residue left in the centrifuge that could affect the pH
- Any dust or little piece of material that was left on the scale

4.2.4 Method of Management/measurement of Controlled Variables

Controlled Variables	**Methods of Managements**
1. Type of chemicals used to produce kidney stone replicas. (Calcium Oxalate formed by a reaction between Sodium oxalate and Calcium nitrate)	
2. Size of beakers Fruit juices are kept in	2. Beakers are meassuerd as 250 ml with 0.1 ml uncertainity.
3. Amount of fruit juice added to the Calcium Oxalate solution	3.Two drops of juice is added into each sample by a dropper
4. Duration of experiment	4.Each sample is going to be in centrifuge for 10 seconds, and each sample will be filtered for 10 seconds. Then each sample will be dried in oven overnight for more accurate measurement.
5. Temperature of the water used	5.Water bath at 37^0C is used to implement body temperature.
6. pH of the water used	6.pH of the water used was 6.45
7. Filter paper used for filtering the solution	7.Filter papers are from the same box and cut with a scisor buy using compasses for apropriate circular shapes for the filtration process
8. Amount of Calcium Oxalate mixture used in each sample	8.Amount of Calcum oxalate mixture added is measured with a delacate measuring cylindir 10 ml.
9. Concentrations of calcium nitrate and sodium oxalate solutions	9. 1 L of 0.1 $mol.dm^{-3}$ calcium nitrate and sodium oxalate solutions are prepared and used durind the experiment.

4.3 Design of the Experiment

4.3.1. Formation of CaC_2O_4 (Calcium Oxalate)

Calcium Oxalate is formed via a chemical reaction involving Sodium Oxalate ($Na_2C_2O_4$) and Calcium Nitrate ($Ca(NO_3)_2$). Which follows as;

$$Na_2C_2O_4(aq) + Ca(NO_3)_2(aq) \rightarrow CaC_2O_4(s) + NaNO_3(aq)$$

The formation of Calcium Oxalate is made via two solutions, calcium nitrate and sodium oxalate both of them are prepared as 0.1 $mol.dm^{-3}$. When 5 ml of each solution are mixed, the mixture became blured with the formation of calcium oxalate which is an insoluble salt. The precipitate is filtered and dryedin laboratory oven overnight then the chemical can be observed in a crystal form.

4.3.2. Materials & Equipment

- Pure Water (H_2O) 2L.
- Calcium nitrate ($Ca(NO_3)_2$) 20 grams
- Sodium Oxalate ($Na_2C_2O_4$) 20 grams
- Pipette 5ml ±0.01
- Beaker x 5 200 ml
- Filter paper x30 5cm in diameter
- Scissors
- Knife
- 1 Orange
- 1 Lemon
- 1 Greypefruit
- 1 Mandarin
- 10 ml of Grape vinegar
- 10 ml Measuring cylindir x2 ±0.1ml
- 800D Electric Centrifuge 3000RPM/ 6x20ml
- Drying Oven
- Erlenmayer flask

- Vacuum filtration apparatus
- Centrifuge tubes x4
- Volumetric Flask x2 1L
- Electronic Balance ±0.001
- Marker
- Vernier Sensor ±0.01
- pH sensor ±0.01

4.3.3 Procedure

1. Take the filter papers out of the box
2. Use a compass to draw apropriate circles on it to use them for filtration system.
3. Cut the circles from filter paper and put them aside.
4. Put the weighing container on the electronic scale and press rezero button.
5. By the help of a spatula, take solid calcium nitrate from the bottle and weigh 16.410 garms of it.
6. Measure 1000ml of waters pH using a vernier pH sensor
7. Put 16.410 garms of calcium nitrate into 1 L volumetric flask, add some distilled water and solve the solid by swirling and shaking the volumetric flask.
8. After all solid is dissolved continue to add water until the line on the neck of the volumetric flask.
9. Put another weighing container on the electronic scale and press rezero button.
10. By the help of a spatula, take solid sodium oxalate from the bottle and weigh 13.40 garms of it.
11. Put 13.40 garms of sodium oxalate into 1 L volumetric flask, add some distilled water and solve the solid by swirling and shaking the volumetric flask.

12. After all solid is dissolved continue to add water until the line on the neck of the volumetric flask.
13. Place both volumetric flasks into the water bath which was set at 37 ^{0}C previously.
14. Take and cut the citrus fruits by the help of a knife.
15. Squize the juice of each fruit.
16. Save the juices in different beakers.
17. By the help of a 10 ml of graduated cylinder measure 10 ml of calcium nitrate solution.
18. By the help of another 10 ml of graduated cylinder measure 10 ml of sodium oxalate solution.
19. Mix these two solutions in a beaker in the water bath.
20. Wait 10 seconds and put the entire mixture into a centrifuge test tube.
21. Keep the centrifuge running for 10 seconds.
22. Pull out the test tubes
23. Set the test tube on a tube rack and set it aside
24. Plug the fast filteration system into the sink tap
25. Place the cut off circles of filter paper on the filtration system
26. Open the tap and start the filtertion system
27. Add the fruit juice mixture into the filtration system
28. İf there is any residue left in the test tubes clear it out with püre water
29. Pull out the filter paper
30. Repeat the procces 5 times for each fruit juice.
31. Take all the samples then put them into the laboratory oven
32. Dry the samples in the oven for 24 hours
33. Take ou the samples and preserve them in glass sample lamels

34. Then measure each sample on delicate scale while substracting the weight of the filter paper

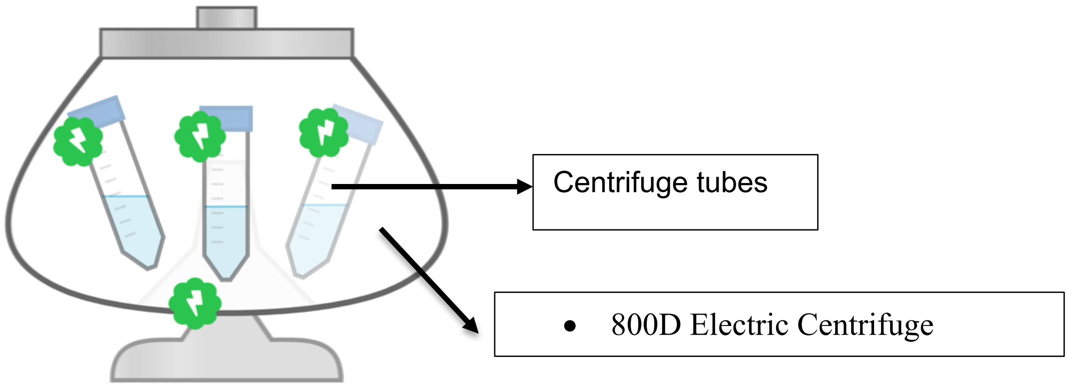


Figure 4.1. Centrifuge

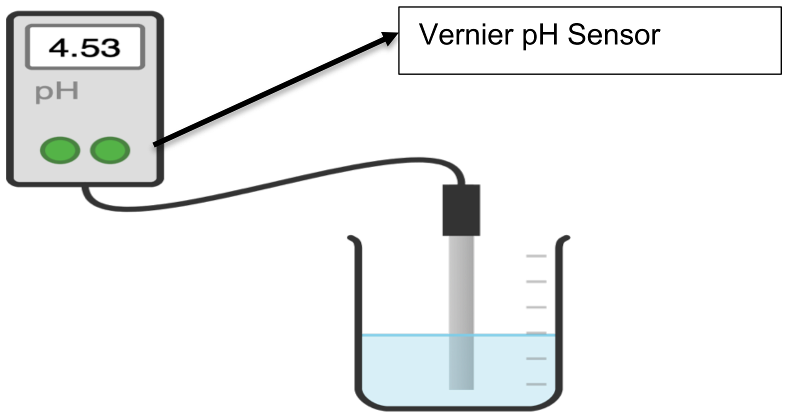


Figure 4.2. pH sensor

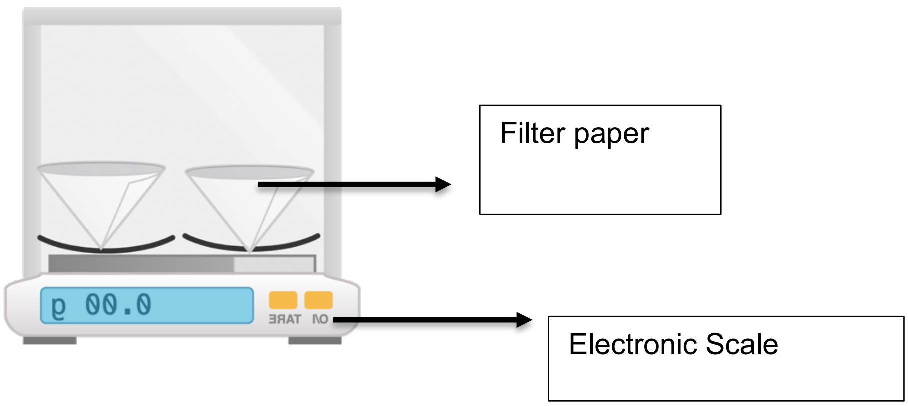


Figure 4.3. Electronic scale

4.3.4. Justification of Experimental Procedure

In my research question I needed to see the diffrent values of Calcium Oxalate residue on the filter paper after it has been cross tested with different pH values. To do that I used 5 different fruit juices, 2 with very high pH value, 1 with middle pH value and 2 with less pH value, and as a control group I obtained a residue without any additional fruit juice added. For the filtration and drying process, I needed to make sure that there was no wrong measuring in the residue, so I centrifuged the samples to make the residue seen more properly in the test tubes, on the other hand drying procces in a laboratory grade oven was nessecary so that no liquid that can cause uncertain measurement would be left on the filtration paper, because this experiment was proceeded with extreme caution. Coming back to my choice of fruits I chose fruits with different pH values to see the difference between the amount of residue that was left in filter papers and confirm my hypothesis.

4.3.5.Risk Assesment

While I was continuing with this experiment, I worked with powder structured chemicals such as Calcium Nitrate and Sodium Oxalate , that under right circumstance inhaling would be harmful to my nose canals and lungss to eliminate the risk of inhaling these chemicals I always wore a mask to protect myself. The solution of these chemicals shouldn’t touch the skin because it might cause alergic reaction and low levels of skin rash, so while doing my experiment I always wore a pair of gloves, and again because I worked with powdery substances with a wind current or bypasser the substances could flow into my eye and cause vision imparement to eliminate this risk I wore a lab grade goggles to protect my eyes. While cutting to fruits I was always careful and used a semi dull knife to protect my hands, and as a last protection procedure, because I used an oven I was wearing heat safe gloves while handling the samples so that I dont get my hands burned.

4.3.6. Environmental and ethical considirations

There is no ethical considerations in my experiment procedure because I didnt use any live subject or a chemical that could harm anyone around me. However for environmental considirations, I used some chemicals that if not got rid of apropriately, it can harm the environment. To do that I got rid of the excess Calcium oxalate residues by diluting the solutions with water and got rid of the through labratory sink. Then got rid of the any one time use labrotory equipment through biohazard container in our labratory.

5. Data Analysis

5.1. Qualitative Data

In the experiment there has been some visual qualities, for example when we mixed the sodium oxalate compound and the calcium nitrate compound, the resulting solution was cloudy inside, and then some small crystal like precipitate residue with a white colour appears on the bottom of the test tubes, when the fruit juices are added, water gets a bit less cloudy, because the fruit juices prevent precipitate residue from forming at the bottom of the test tube,

Other than that fruit juices had all bright colour and freshly squeezed, resulting in best observation of pH effect on precipitate mass dissolving process.

5.2. Quantitative Data

Type of Fruit	Trials	Volume of the fruit juice added (drops)	Mass of the filter paper (g) ±0.001	Precipitate value + Filter paper (g) ±0.001
Control	1	2	0.225	0.244
	2		0.224	0.245
	3		0.225	0.244
	4		0.225	0.243
	5		0.224	0.244
Lemon	1	2	0.225	0.237
	2		0.224	0.236
	3		0.225	0.235
	4		0.225	0.237
	5		0.224	0.236
Vinegar	1	2	0.225	0.234
	2		0.224	0.233
	3		0.225	0.232
	4		0.225	0.232
	5		0.224	0.233
Grapefruit	1	2	0.225	0.239
	2		0.224	0.241
	3		0.225	0.239
	4		0.225	0.238
	5		0.224	0.241
Mandarin	1	2	0.225	0.243
	2		0.224	0.242
	3		0.225	0.242
	4		0.225	0.243
	5		0.224	0.242
Orange	1	2	0.225	0.239
	2		0.224	0.242
	3		0.225	0.241
	4		0.225	0.242
	5		0.224	0.242

Table 5.1 Raw Data Table

5.3. Data Processing

- Calculation of mass of precipitate;

Equation;

Mass of filter paper + Precipitate (g) – Mass of Filter Paper (g) = Mass of Precipitate (g)

±0.001(g) ±0.001(g) ±0.002(g)

- Mean Mass of precipitatate

$$\frac{x_1 + x_2 + x_3 + x_4 + x_5}{5} = Mean\ Mass\ of\ Precipitate(g)$$

1.Control

$$\frac{0.019 + 0.021 + 0.019 + 0.018 + 0.020}{5} = 0.019$$

2.Lemon

$$\frac{0.012 + 0.012 + 0.010 + 0.012 + 0.012}{5} = 0.012$$

3.Vinegar

$$\frac{0.009 + 0.009 + 0.007 + 0.007 + 0.009}{5} = 0.008$$

4.Grapefruit

$$\frac{0.014 + 0.017 + 0.014 + 0.013 + 0.017}{5} = 0.015$$

5.Orange

$$\frac{0.014 + 0.018 + 0.016 + 0.017 + 0.018}{5} = 0.017$$

6.Mandarin

$$\frac{0.018 + 0.018 + 0.017 + 0.018 + 0.018}{5} = 0.018$$

- Mean Mass of Precipitate Uncertanity

$$\frac{max - min}{2} = uncertainity$$

1.Lemon

$$\frac{0.012 - 0.010}{2} = \pm 0.001$$

2.Control

$$\frac{0.021 - 0.018}{2} = \pm 0.0015$$

3.Vinegar

$$\frac{0.009 - 0.007}{2} = \pm 0.001$$

4.Grapefruit

$$\frac{0.017 - 0.013}{2} = \pm 0.002$$

5.Orange

$$\frac{0.018 - 0.014}{2} = \pm 0.002$$

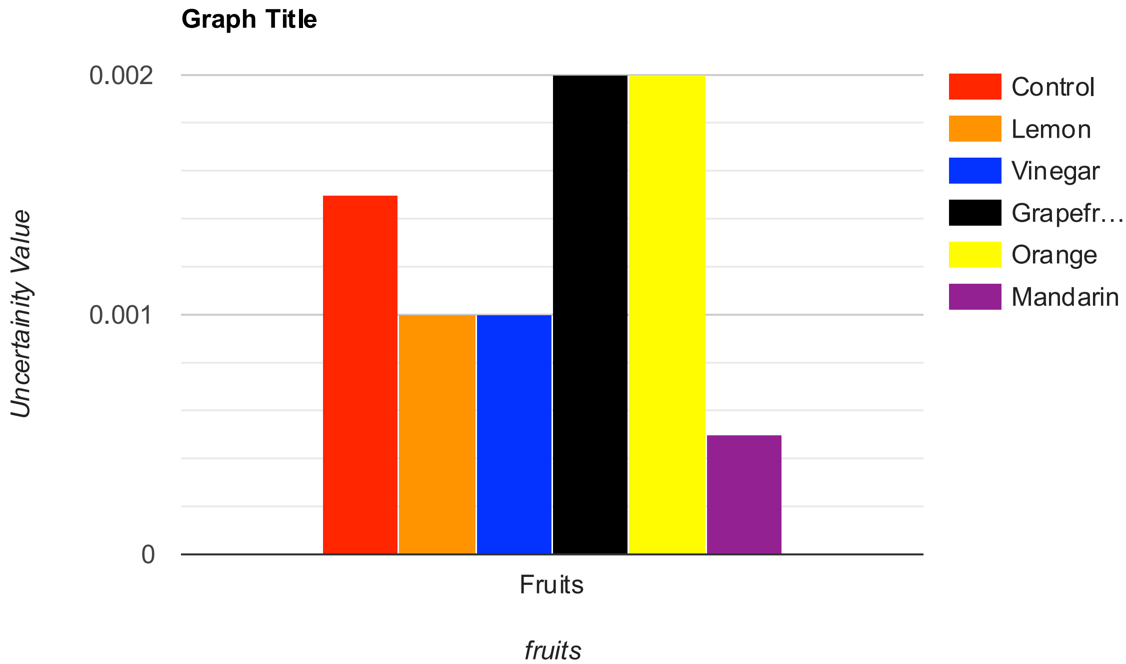
6.Manadarin

$$\frac{0.018 - 0.017}{2} = \pm 0.0005$$

a) Processed Data Tables

Type of Fruit	Trials	Mass of Precipitate (g) ±0.002(g)
Control	1	0.019
	2	0.021
	3	0.019
	4	0.018
	5	0.020
Lemon	1	0.012
	2	0.012
	3	0.010
	4	0.012
	5	0.012
Vinegar	1	0.009
	2	0.009
	3	0.007
	4	0.007
	5	0.009
Grapefruit	1	0.014
	2	0.017
	3	0.014
	4	0.013
	5	0.017
Mandarin	1	0.018
	2	0.018
	3	0.017
	4	0.018
	5	0.018
Orange	1	0.014
	2	0.018
	3	0.016
	4	0.017
	5	0.018

Table 5.2. Mass of Precipiptate



Graph 5.1 Mean Uncertainity Bargraph

As we can see the bargraph of mean uncertainity values doesnt allign with the supposed ±0.001g uncertainity, only lemon and vinegar seem to match up with this uncertainity that was given on the electronic balance I was working with. This shows that there is a value of random errors in the experiment other than lemon and vinegar.

- Calculating the standart deviation

$$SD = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}}$$

1.Control

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0.018 - 0.0194)^2 + ... + (0.021 - 0.0194)^2}{5}$$

$$= \frac{5.2E\text{-}6}{5}$$

$$= 1.04E\text{-}6$$

$\sigma = \sqrt{1.04E-6}$

$= 0.0010198039027186$

2.Lemon

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0.018 - 0.0194)^2 + \ldots + (0.021 - 0.0194)^2}{5}$$

$$= \frac{5.2E-6}{5}$$

$= 1.04E-6$

$\sigma = \sqrt{1.04E-6}$

$= 0.0010198039027186$

3.Vinegar

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0 - 1.5053333333333)^2 + \ldots + (0.009 - 1.5053333333333)^2}{6}$$

$$= \frac{67.404089333333}{6}$$

$= 11.234014888889$

$\sigma = \sqrt{11.234014888889}$

$= 3.3517181995044$

4.Grapefruits

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0 - 1.5053333333333)^2 + \ldots + (0.009 - 1.5053333333333)^2}{6}$$

$$= \frac{67.404089333333}{6}$$

$= 11.234014888889$

$\sigma = \sqrt{11.234014888889}$

$= 3.3517181995044$

5.Orange

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0 - 1.5053333333333)^2 + ... + (0.009 - 1.5053333333333)^2}{6}$$

$$= \frac{67.404089333333}{6}$$

$= 11.234014888889$

$\sigma = \sqrt{11.234014888889}$

$= 3.3517181995044$

6.Mandarin

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(0 - 1.5053333333333)^2 + ... + (0.009 - 1.5053333333333)^2}{6}$$

$$= \frac{67.404089333333}{6}$$

$= 11.234014888889$

$\sigma = \sqrt{11.234014888889}$

$= 3.3517181995044$

- Calculating the Standart Error

$$SE = \frac{\sigma}{\sqrt{n}}$$

1.Control

= 0.000509901951359

2.Lemon

=0.0004

3.Vinegar

=0.000489897948557

4.Grapefruit

=0.000836660026534

5.Orange

=0.000748331477355

6.Mandarin

= 0.0002

	Standard Error	Standard Deviation
Control	0.001	0.0005
Lemon	0.0004	0.001
Vinegar	0.0004	0.335
Grapefruit	0.0008	0.335
Orange	0.0007	0.335
Mandarin	0.0002	0.335

Table1.4 (Standard error and standard deviatpn table)

Calculation of % decrease in mass of Calcium

Equation

$$\frac{Mass\ of\ Calcium\ Oxalate\ left\ in\ filter\ paper - Precipitate\ mass\ of\ Calcium\ Oxalate\ residue}{Precipitate\ mass\ of\ Control\ Group} X100 =$$

% decrease in mass of Calcium Oxalate ±0.002

1.Control

$$\frac{0.0194 - 0.0194}{0.0194} X100 = 0$$

2.Lemon

$$\frac{0.0194 - 0.0116}{0.0194} X100 = 40.20\% \pm 0.002$$

3.Vinegar

$$\frac{0.0194 - 0.0082}{0.0194} X100 = 57.73\% \pm 0.002$$

4.Grapefruit

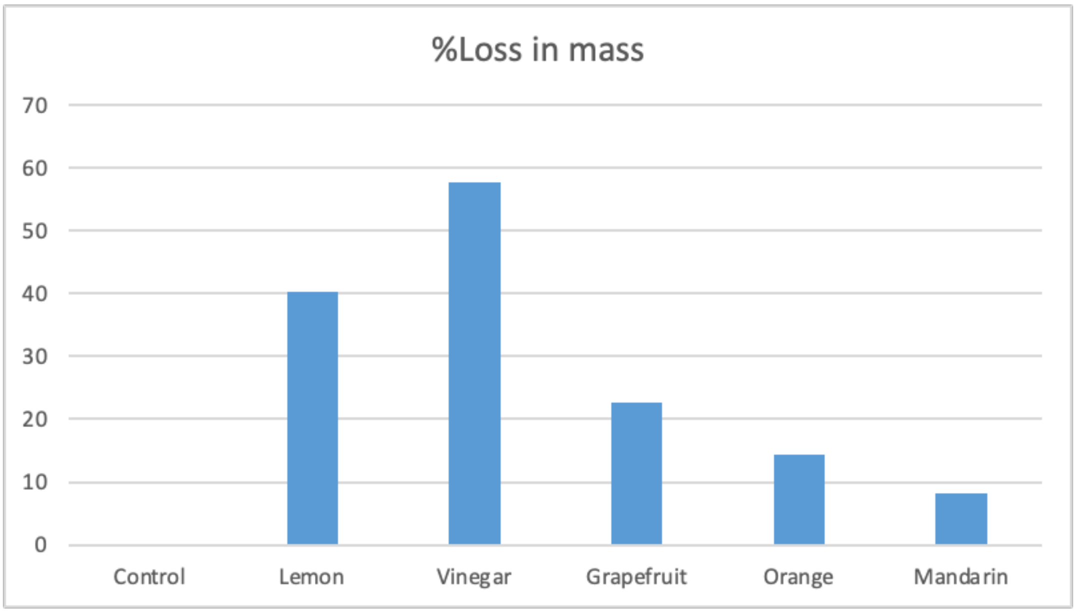
$$\frac{0.0194 - 0.015}{0.0194} X100 = 22.68\% \pm 0.002$$

5.Orange

$$\frac{0.0194 - 0.0166}{0.0194} X100 = 14.43\% \pm 0.002$$

6.Mandarin

$$\frac{0.0194 - 0.0178}{0.0194} X100 = 8.24\% \pm 0.002$$



Graph 5.2 (Bargraph of % loss of mass)

As we can see from the bar graph created from the data processed, vinegar had the highest percentage loss of mass and mandarin had the least out of all, this shows us that vinegar dissolves more and therefore its more acidic and mandarin dissolved less which means has less acidic content.

6. Conclusion

In the table seen 5.2. (bargraph of % loss of mass) different kind of acidic components gave different values of percentage mass of precipitate, for example vinegar which has the lowest pH of them all, because it has acetic acid which provides less of a pH value compared to other fruits in this list which contain citric acid. It provided 57.73% percent decrease in precipitate mass which is the highest percentage in loss of mass. If we compare it to a fruit with less acidic nature, for example mandarin which contains small amount of citric acid while it has a high sugar content, it provides only 8.24% percent loss on precipitate mass. This comparecent shows that compounds with lower pH tends to dissolve more precipitate calcium oxalate . So as it comes to which fruit juice is most beneficial to dissolve kidney stones even though vinegar had the most decrease in % mass of precipitate, its highly acidic nature and the damage it can do to someones stomach lining is at a high level so its consumption is not viable for daily usage. In the other hand lemon was the second best dissolvent and its pH is higher than acetic acid so its viable for daily consumption and it provides vitamins and enzymes that are very important to imune system, so its consumption would be a good choice. The other viable choice is grapefruit which provided 22.68% loss of precipitate mass, and aside from that the flesh of grapefruit provides more vitamins and enzymes that is significantly healthy for your digestive system. So regarding to my hypothesis, the fruit that would be most viable for treating the kidney stones is grapefruit, thanks to its balanced acidic nature and extra beneficial vitamins that it provides.

6.1 Justification in scientific context

$$HC_2O_{4\,(aq)} \rightleftharpoons H^+_{(aq)} + C_2O^{2-}_{4\,(aq)}$$

In this chemical reaction when pH drops H^+ concentration increases, because of that equilibrium shifts to left, and this decreases the concentration of oxalate, because the concentration of oxalate decreased, this reaction prevents it from forming precipitate residue.

$$Ca_2C_2O_{4\,(s)} \rightleftharpoons Ca^{2+}_{(aq)} + C_2O^{2-}_{4\,(aq)}$$

The H^+ion gets into a chemical reaction with oxalate equilibrium shifts to right and allows the already existing Stones to disintegrate, and allows kidney Stones to break down into smaller pieces.

7. Evaluation

After calculating the Standard error and uncertainity of every fruit, results show that standard erros of the fruits were less of a value than uncertainity of systematic devices that were used to measure compounds. Because the standard error is less than uncertainity, this shows us that there is only random errors that is present during trials. To prevent these random errors I have came up with 2 propositions, for example a more precise measuring device can be used to reduce the random error. Another solution to fixing random errors would be increasing the amount of trials done.

7.1. *Strengths*

While doing this experiment I was able to start the experiment session with a well developed subject and a overall delicately planned experimental methodology, so the eperiment phase got handled pretty easily and with high efficiency, aside from that the subject chosen was extremely good for an extended essay research question, and this subject being viable made the process more efficent once again.

7.2. Limitations

During the experiment, I couldn’t get results that would benefit an actual patient in real life, because to get an acurate result I had to use urine with real kidney stone disease, but because I couldn’t get my hands on such specimen I had to use a kidney stone substitute. Other than that I had to use so little amount of fruit juice specimens, if I used more fruits like passion fruit or lime I could have a bigger specimen table, but I couldn’t access those fruit in my region.

7.3. Extensions

As extensions if I do this experiment one more time and have more resources , I would try to use more similar substances and research environment. For example, instead of using Calcium Oxalate, I would use actual urine which is contaminated with kidney stones for better results, or I could add uric acid inside the Calcium oxalate solution to create a urine like environment for more real life acurate test results, and help me measure its ionisation levels, pH more acurate. On the other hand I would also use more kinds of fruit juices and mix them with enzymes, so that I could work on more specimen which some of them whold have a better chance at being the viable option.

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