FRUITY VITAMIN C

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Background Information

What are Vitamins?

- ***Vitamins are organic molecules that mainly function as catalysts in the body. A catalyst is a substance that allows a chemical reaction to occur using less energy and less time than it would normally.***
- ***There are two types of vitamins:***
  1. ***Fat soluble vitamins are stored in fat tissues in the body and liver, e.g. vitamin A, D, E,***
  2. ***Water soluble vitamins travel through bloodstream. They travel faster and are excreted faster compared to fat soluble vitamins. E.g. Vitamin C.***
- ***Cells use vitamins by changing them into molecules that combine with enzyme which control chemical activities.***

What is Vitamin C?

- ***Vitamin C is also referred to as ascorbic acid or ascorbate.***
- ***It is an odourless, white solid.***
- ***Its chemical formula is $C_6H_8O_6$.***

Why Vitamin C is important?

Vitamin C is an essential water soluble nutrient for humans and certain other animal species. It is very important because it is required by your body to be kept good health through main maintenances. Furthermore, it is a necessary component for metabolism which gives normal growth.

Vitamin C helps….

- ***Form connective tissues, blood vessel walls, ligaments and tendons.***
- ***Growth and repair of tissues***
- ***Fight bacterial infections***
- ***Aid in red blood cell formation***
- ***Maintain bones and teeth***

The Anti-Oxidant Vitamin C

- ***Anti-oxidants block some damages that are caused by free radicals (which are molecules produced by the body that damage DNA). A build-up of free radicals overtime may contribute to aging process and development of health conditions e.g. cancer, heart disease.***
- ***Vitamin C is an anti-oxidant that helps prevent some damages from free radicals caused from the inhale of tobacco (smoking), radiation or the digestion of food.***

The Anti-Oxidant Vitamin C

- ***Vitamin C protects the fat-soluble vitamins A and E and fatty acid from oxidation.***
- ***The process is:***
  1. ***Vitamin C, is a good source of electrons.***
  2. ***It donates electrons to free radicals (which are molecules with unpaired electrons, and this is very harmful to the body because of their high reactivity) and quench their reactivity.***
  3. ***Therefore, vitamin C is a reducing agent (which is a chemical species which provide electrons for other chemical species).***
  4. ***After neutralising the free radical, antioxidant becomes inactive and this means they need to be constantly re-supplied to our body through the right foods.***

We Need Vitamin C!

Humans are one of the few species that lack the enzyme to convert glucose to vitamin C. Since this vitamin is quickly excreted and the human body cannot synthesis it, it has to be ingested frequently by seeking it from other sources. The richest natural Vitamin C is found in many fruits and vegetables, and citrus fruits are not the only significant sources of vitamin C.

In Australia, the RDA (recommended daily allowance) of vitamin C for female adult is 75mg and male adult is 90mg.

Vitamin C in Fruits

- ***Ascorbic acid is associated with chloroplasts and helps the oxidative stress of photosynthesis.***
- ***It also has roles in cell division and protein modification, although precise details of how plants produce its ascorbate remain unknown.***

Vitamin C in Many Fruits

- ***Citrus fruits include fruits such as lemon, oranges, and mandarin. They are rich in vitamin C.***
- ***Papaya grows in tropical climates. It is ranked first on nutritional scores amongst 38 fruits based on the percentage of the United States Recommended Daily Allowances (RDA) for a number of nutrition. One large papaya is packed with 235 milligrams of vitamin C, and that is two or three times more than the RDA.***
- ***Kiwi fruit contains lots of vitamin C and one medium kiwi provides about 95 percent of the RDA for vitamin C. It ranks high on the antioxidant scale.***

Variations of Vitamins in Plants

- ***Plants are generally a good source of vitamin C, but the amount in food of plants depends on the precise variety of the plant, soil condition, climate where it grew, length of time since it was pick, stored conditions, and method of preparation.***
- ***Most researches are approximate.***
- ***The data are usually subject to potential variation and difficulties for comparison because of the different variables mentioned above.***
- ***Usually the amounts of vitamin C in fruits are measured in milligrams per 100 grams of fruit.***

Relating to Experiment Process

- ***Titration is technique where a solution of known concentration is added to a known solution, until a reaction occur between them.***
- ***Iodine (I_2) becomes a blue complex when added to starch, because when the iodine atoms sit inside the glucose molecules, the bonds pull electrons into different positions, changing how iodine absorb and emit light. Because of this process, iodine can act as its own indicator.***
- ***The complex is useful for indicating redox titrations as colour change is sharp.***

Relating to Experiment Process

Oxidation and Reduction are opposite processes of each other.

1. ***As a reducing agent, ascorbic acid is easily oxidised. – This means it quickly give away electrons where possible.***
2. ***Iodine, on the other hand, is an oxidising agent, – This means it will ‘reduce’ or take away electrons.***
3. ***Therefore, the ascorbic acid gives iodine an electron and turns it into iodide.***
4. ***Iodide will not turn starch blue, and therefore an Iodine/starch solution will become clear.***

Relating to Experiment Process

- ***In this experiment, it uses this phenomenon in a reduction/oxidation (redox) titration, where the vitamin C reduces the solution of iodine to the colourless iodide ion.***
- ***Presence of metal ions and light accelerate its redox reaction.***

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THE
EXPERIMENT!!

Hypothesis:

The juice from orange fruit contains the most vitamin C.

Aim

To find out The juice of which fruit contain the most vitamin C

Equipment

- **Equipment:**
- Stainless steel pot and lid
- 3 Glass bowls
- Baking rack
- Measuring cup
- Teaspoon
- Spoon (to stir)
- Syringe
- Pen and masking tape (for labelling)
- Knife
- 2 plastic cups

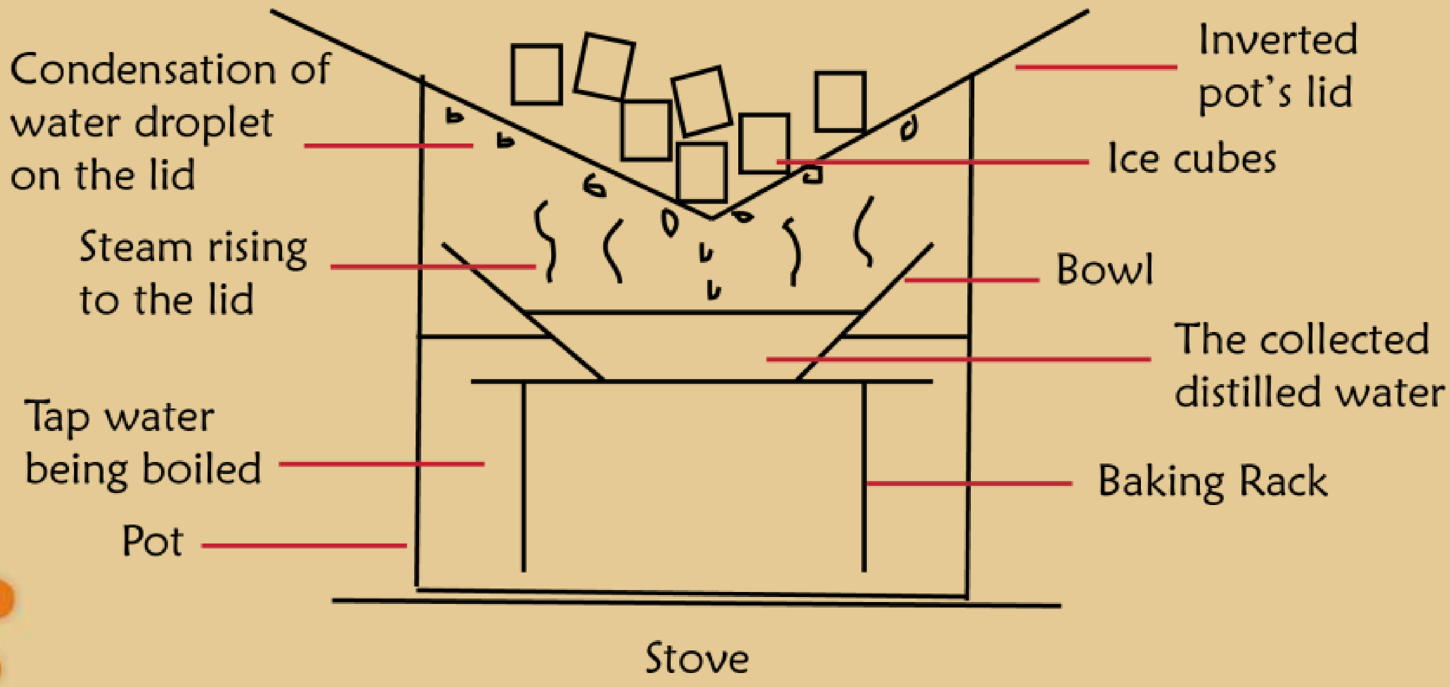
- **Ingredients:**
- Ice
- Tap water (for distilled water)
- 2/3 teaspoon of corn starch
- 5 drops of iodine
- 500mg Vitamin C tablet

- **Fruits**
- Orange
- Watermelon
- Kiwi
- Lemon
- Grapes
- Papaya
- Mandarin

METHOD PART A
Making Distilled Water

1. Fill a stainless steel pot about halfway full with tap water.
2. Place a glass bowl on a baking rack in the pot and ensure water cannot get inside the bowl.
3. Invert the pot's lid and fill it with ice so when hot steam hits the cold lid, a condensation effect will be created.
4. Boil the water in the pot, causing the steam to rise and condense on the pot's lid, and distilled water will drip into the bowl.
5. Pour the distilled water into a measuring cup, and continue this process until there's 200ml of distilled water.
6. Allow the water to cool.
7. Repeat steps 1-5 again to make another 250ml of distilled water needed for Part C and also allow the water to cool.

Diagram A



NOTE: Diagrams A, B1, B2, C, D and E are used to represent the arrangement of different parts of the experiment.

METHOD PART B
Making Vitamin C Indicator

1. Pour 50mL of cold distilled water into a glass bowl (So pour from the previous measuring cup until the distilled water is up to 150mL).
2. Add 2/3 teaspoon of corn starch in 50ml of cold distilled water measured by a measuring cup.
3. Stir the starch mixture with a spoon.
4. Put the starch mixture into a bowl and microwave it for 1-2mins.
5. Cool the starch mixture (which is now starch solution).
6. Add 5mL of starch solution using a syringe, to the 150mL distilled water in the measuring cup.
7. Stir it with a spoon until it’s mixed evenly.
8. Add 6 drops of iodine using the washed syringe, and stir the mixture (which now becomes the Vitamin C indicator of a dark blue colour).
9. Label this mixture –‘Vitamin C indicator’ (–a.k.a ‘Starch/Iodine Solution’).

Diagram B1

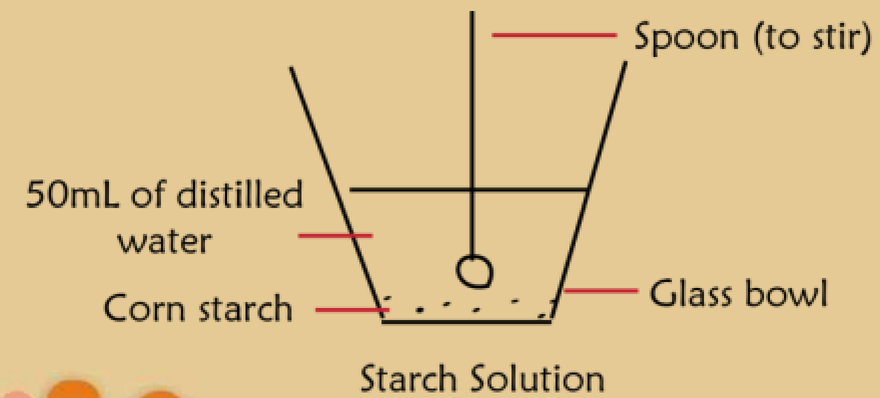
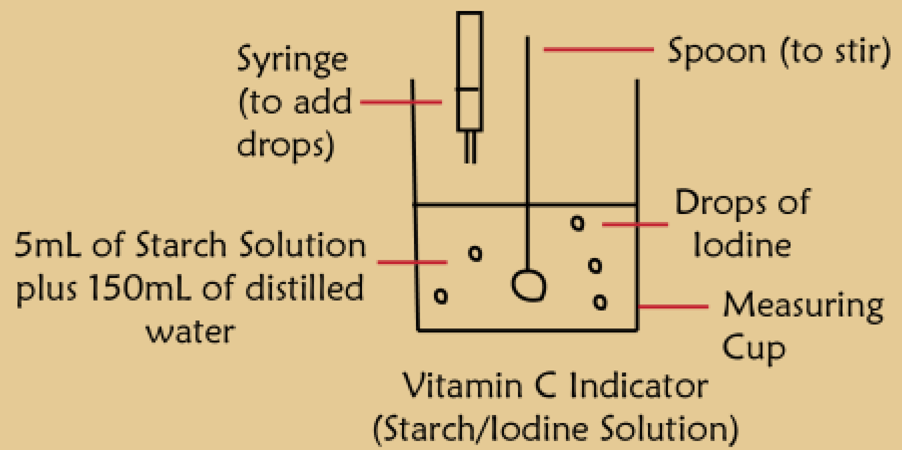


Diagram B2

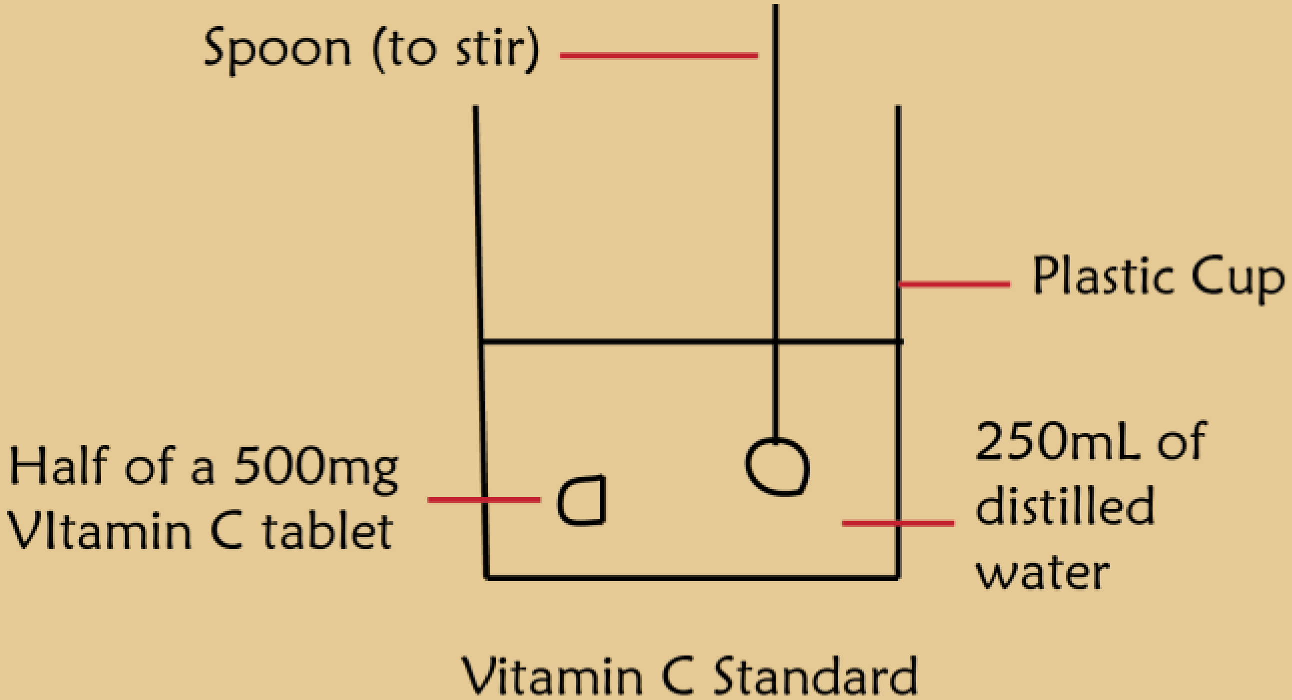


NOTE: Diagrams A, B1, B2, C, D and E are used to represent the arrangement of different parts of the experiment.

METHOD PART C
Vitamin C Standard 1mg/1ml

1. Prepare a 500mg Vitamin C standard tablet.
2. Cut the 500mg Vitamin C tablet in half with a knife.
3. Measure 250ml of distilled water with a measuring cup and pour it into a plastic cup.
4. Add one half of the Vitamin C tablet (now 250mg Vitamin C) to the plastic cup.
5. Stir the mixture with a spoon until the tablet is dissolved and mixed evenly (now 250 mg per 250 ml =1mg/1ml).
6. Label this cup as ‘Vitamin C Standard’.

Diagram C



NOTE: Diagrams A, B1, B2, C, D and E are used to represent the arrangement of different parts of the experiment.

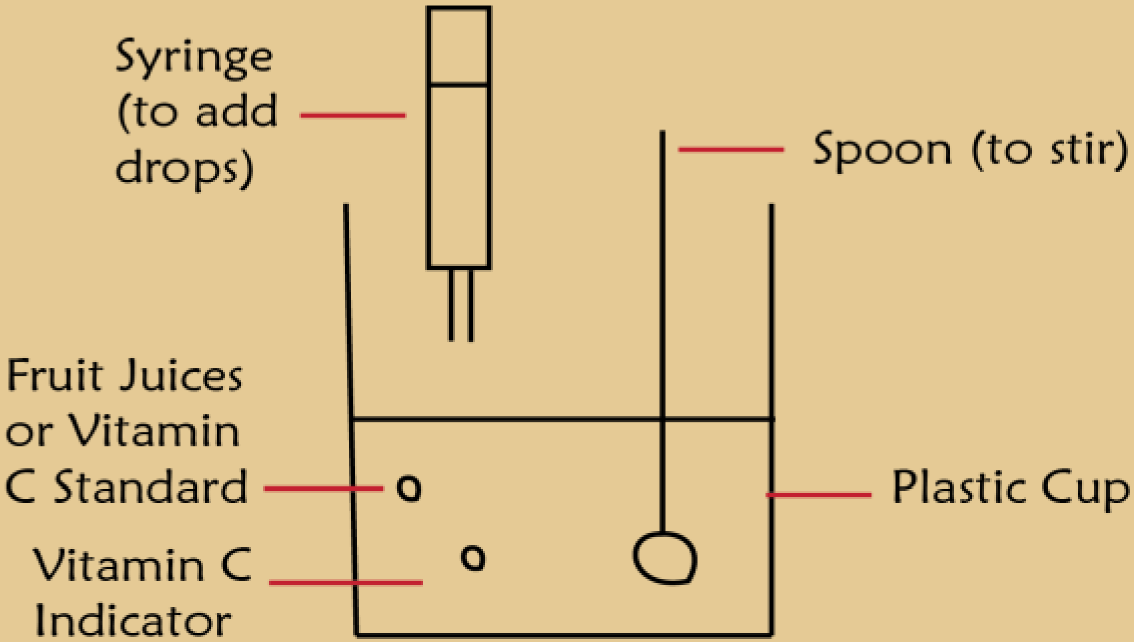
METHOD PART D
The Test

1. Use a syringe and squeeze the Vitamin C standard into it.
2. Measure 15mL of Vitamin C Indicator with a measuring cup and pour it into a plastic cup.
3. Add a drop of Vitamin C Standard from the syringe to the Vitamin C Indicator in the cup.
4. Stir it with a spoon.
5. Continue to add drops of Vitamin C Standard, while stirring after each drop, until the colour of the indicator changes from blue to clear (or pale blue).
6. Count the number of drops needed to change the colour and record it in the results table. The lower number of drops required to titrate the indicator, the greater the amount of vitamin C in the liquid.

METHOD PART D
The Test

7. Prepare the fruits: Orange, watermelon, kiwi, lemon, grapes, papaya and mandarin.
8. Cut a fruit into a slice with a knife.
9. Place the fruit in a bowl and crush its pulp with a spoon to make the fresh fruit juice.
10. Use the washed syringe and squeeze the juice into it.
11. Measure 15mL of vitamin C indicator with a measuring cup, and pour into a plastic cup.
12. Add a drop of fruit juice from the syringe to the Vitamin C indicator in the cup
13. Stir it
14. Continue to add drops of juice, while stirring after each drop, until the colour of the indicator changes from blue to clear (when solution returns to juice's natural colour)
15. Count the number of drops needed to change the colour and record it in the results table. The lower number of drops required to titrate the indicator, the greater the amount of vitamin C in the liquid.
16. Repeat steps 8-15 with all the fruits that are tested.
17. Repeat 1-16 two more times, and then calculate the average number of drops so that the results become more reliable.

Diagram D



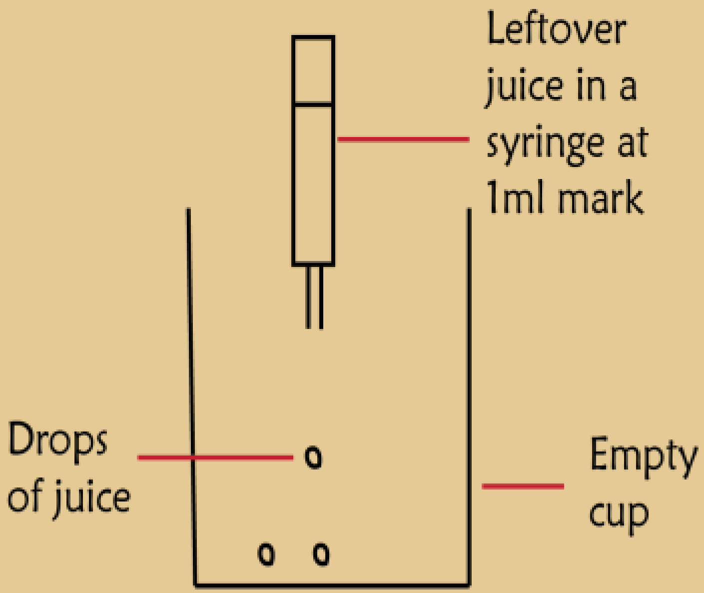
NOTE: Diagrams A, B1, B2, C, D and E are used to represent the arrangement of different parts of the experiment.

METHOD PART E

Determine how many drops equals to 1ml (this is for calculations)

1. Squeeze one of the leftover juices into the syringe until it reaches the 1ml mark.
2. Count the number of drops it takes for the 1ml of liquid to finish (squeezed out from syringe).
3. Record this in a separate results table.
4. Repeat step 1-3 another two times and calculate the average so it is reliable.
5. Under the table, write “1ml equals to [number of drops]”.

Diagram E



Determining how many drops equal to 1mL

NOTE: Diagrams A, B1, B2, C, D and E are used to represent the arrangement of different parts of the experiment.

Variables

- **Independent Variable:**
  Different types of fruits are tested
- **Dependent Variable:**
  The concentration of Vitamin C in fruits is measured from the amount of drops of fruit juices counted to change the Vitamin C Indicator solution from blue to clear.
- **Controlled Variables:**
  - ✓ Same temperature of all the juices
  - ✓ Same temperature of Vitamin C indicator
  - ✓ Same amount of Vitamin C Indicator used each trial for each fruit
  - ✓ Same stirring pace
  - ✓ Same-sized container where the titration takes place.

Variables

- **The Control:**
 The Vitamin C Standard made from half a 500mg Vitamin C tablet is dissolved in water to create a ratio of 1mg of vitamin C in 1ml (1mg/ml). This control is used to calculate the concentration of Vitamin C content in each fruit, with a formula. In the results, the vitamin C standard can be used to compare with other fruits' vitamin C contents and this can help develop further understanding when analysing the results. It also confirms that it is indeed the Vitamin C in fruits that is causing the Iodine/Starch indicator to turn colourless.

Risk Assessments

1. Wear oven gloves when handling with hot water as it can burn your hand.
2. Wear safety glasses when crushing the fruits into juice because the juice can get into your eyes and irritate it.

Photos!

Photogrpahic Evidence Of Experiment Process

Distallation of water

Preparation of fruits and other ingerdients and equipments

2/3 teaspoon of corn starch

Photogrpahic Evidence Of Experiment Process

Add 5mL of starch solution using a syringe, to the 150mL distilled water in the measuring cup

Starch/Iodine Solution - a.k.a 'Vitamin C indicator'

The finishing looks....

RESULTS...

Results Tables

Number of drops (drops)

Control	Trial 1	Trial 2	Trial 3	Average
Vitamin C Standard	23	26	22	23.7

Fruits	Trial 1	Trial 2	Trial 3	Average
Orange	53	54	54	53.7
Watermelon	80	81	79	80.0
Kiwi	47	45	49	47.0
Lemon	54	66	64	61.3
Grapes	122	119	122	121.0
Papaya	40	41	44	41.7
Mandarin	73	79	76	76.0

(drops)

	Trial 1	Trial 2	Trial 3	Average
Number of drops equal to 1mL	18	17	16	17

1ml equals to 17 drops.

Calculation

250mg tablet was dissolved in 250mL of distilled water.
Therefore, Vitamin C Concentration =250mg/250mL
=1mg/ml
23.7 drops of Vitamin C Standard was needed to complete titration.
→ This number was rounded off to 24 drops

If 17 drops =1ml
then 24 drops =24 /17ml
=1.41ml
Therefore,
it took 1.41ml of Vitamin C standard to complete the titration.

FORMULA
Y= 24/X*1.41
(Where X= number of drops of fruit
Y= concentration of Vitamin C mg/ml)
Then, Y*100 = concentration of vitamin C mg/100g ←which is the usual measurement when comparing fruits

Table from Calculations

Control	Average number of drops for titration (drops)	Vitamin C Concentration (mg/ml)	Vitamin C Concentration (mg/100g)
Vitamin C Standard	23.7	1.428	142.8

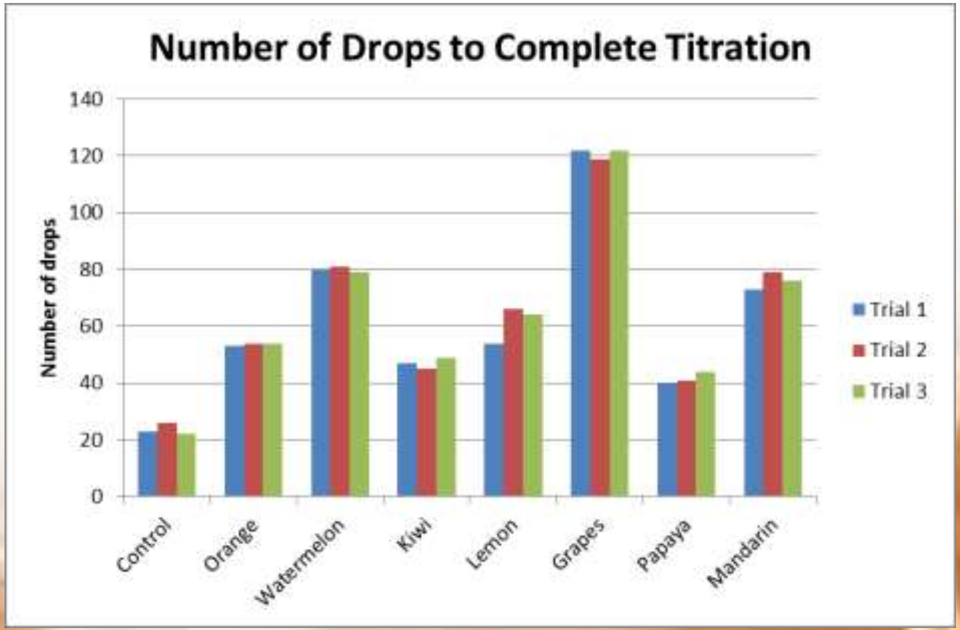
Fruits	Average number of drops for titration (drops)	Vitamin C Concentration (mg/ml)	Vitamin C Concentration (mg/100g)
Papaya	41.7	0.812	81.2
Kiwi	47	0.720	72
Orange	53.7	0.630	63
Lemon	61.3	0.552	55.2
Mandarin	76	0.445	44.5
Watermelon	80	0.423	42.3
Grapes	121	0.280	28.0

Photographic Evidence of Results

Analysis of results

Graph 1 is just a general column graph with the results from all three trials colour coded by the colours of red, green and blue. Both graph 2 and graph 3 are column graphs that have reordered the fruits from the highest to lowest concentration of Vitamin C, as it is easier to see and analysis.

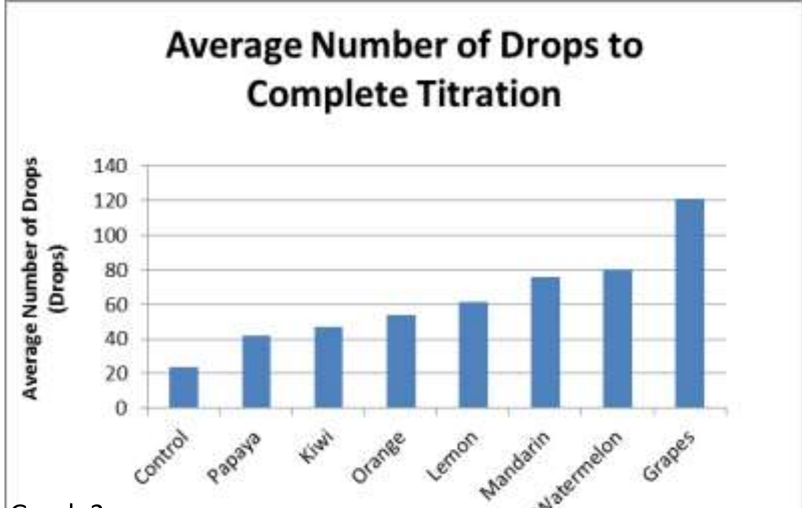
Graph 1



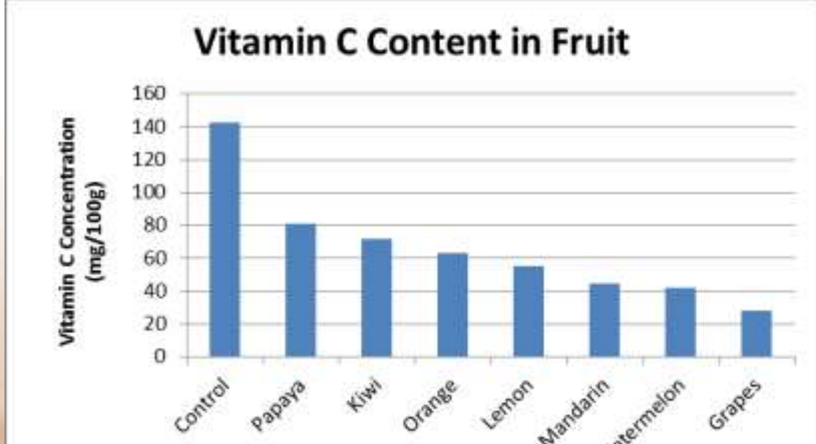
Analysis of results

Like expected, the control, Vitamin C Standard of 1mg/ml, contains the most Vitamin C as it is made from a Vitamin C tablet. It contains about twice as much Vitamin C as a 100g of Kiwi fruit. As researched from the background information, it is not surprising that both papaya and kiwi are very rich in vitamin C. The vitamin C concentration of papaya is 81.2mg/100g and for kiwi was 72mg/100g, while for orange was 63mg/100g. Although both lemon and mandarin are citrus fruits, their results are not very high when compared. Meanwhile, Watermelon and grapes have even less vitamin C.

From the fruits tested, it is seen in graph 3 that Papaya, which used the least amount of drops, has the most amount of vitamin C. Grapes is the exact opposite with the most amount of drops and least amount of vitamin C.



Graph 2

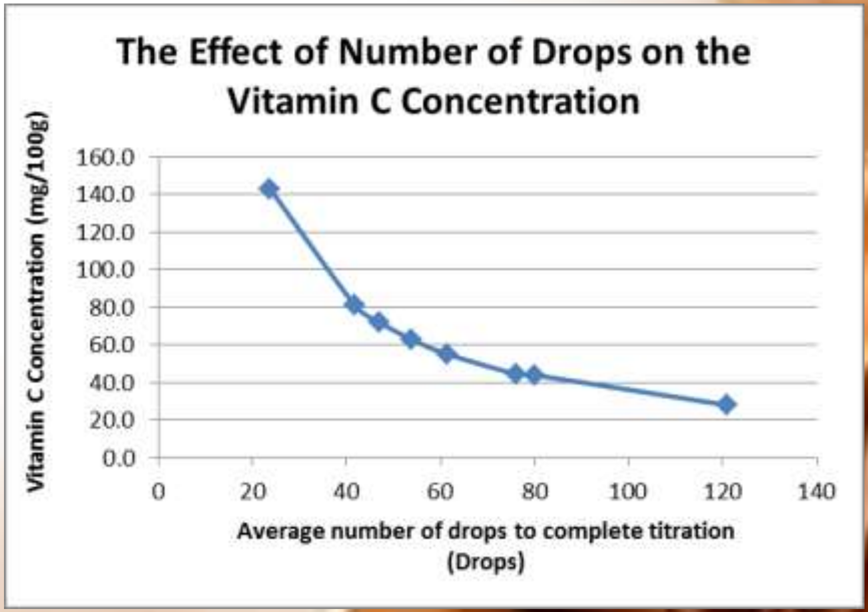


Graph 3

Analysis of results

By looking at both of graph 2 and 3, a pattern is evident. The less amounts of drops needed to complete titration (shown in graph 2), the more vitamin C it contains (shown in graph 3). Therefore, graph 4 is created to effectively show the relationship between these two factors as inverse proportions: As the number of drops needed to complete titration increases, there will be less vitamin C content present in each drop of juice, hence the vitamin C content decreases in the fruit. The reason for this is that there is a certain amount of vitamin C needed to turn the blue starch/iodine solution to clear.

The different concentration of vitamin C in each drop will affect the different amounts of drops needed to add up to that certain amount for completing titration.



Graph 4

CONCLUSION

It was found that the juice from papaya contains the most amount of vitamin C the juice from grapes contain the least amount.

Discussion

- This experiment was tested to find out which fruit (from a list of various fruits) has the most amount of vitamin C. Learning more about the topic during the research, the RDA (recommended daily allowance) for vitamin C also became a factor that can be included in part of conclusion, as to determine which fruits were the best sources of vitamin C and can easily satisfy the RDA so our bodies can healthily grow and function.
- From the results, the three fruits that came top for vitamin C concentration were papaya, kiwi and oranges. These fruits are good sources for the RDA which is 75mg for female adult and 90mg for male adult as mentioned in the background information. The results correspond to the research done on the fruits previously about their vitamin C contents and how much percentage of RDA a fruit can fulfil.

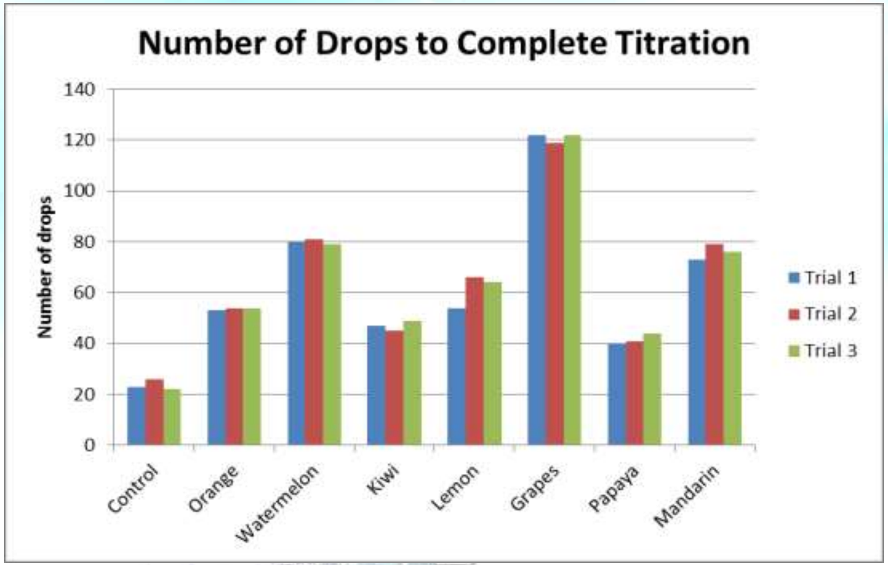
Discussion

This experiment is valid because it tests the hypothesis made with a logical method. It has one independent variable, which is the different fruits tested; one dependent variable which is the amount of vitamin C they contain; and the rest of other variables are kept the same. The experiment also effectively uses a control to calculate the vitamin C concentration. In addition, it makes sure that it is the vitamin C causing the colour change in the Vitamin C Indicator.

Discussion

The experiment is repeated several times. There are three trials for each test, and this increases the sample size. A consistent pattern is evident in the result and shown in *Graph 1 (in Results and below)* as the results of the three trials as the three columns for each independent variable are quite similar. This means that there were no major errors affecting the reliability of experiment. Therefore, it is quite reliable.

One way to increase its accuracy, is to average the results from all the trials so that an overall outcome of the entire experiment can be seen without any outliers (perhaps from accidents) affecting it very much. The measurements made for the measuring cup are also read at eye level so I know I am using an accurate amount. Although these have been done, the experiment does not show very accurate and exact results.



Graph 1: number of drops to complete Titration (also shown before in Results)

Discussion

One factor that could affect the accuracy of the experiment is the use of this type of method of titration for testing vitamin C concentration. It is sometimes hard to tell if the Vitamin C Indicator has completely changed to colourless. Fruits with stronger pigments such as watermelon and papaya cover up the pale blue colour of the indicator, while lemon's white colour is much harder to see. Because of this, it is sometimes difficult to determine when the titration process has ended. It is likely that the watermelon were thought to have completed the titration with less drops of juice (as the red already look very strong), while lemons with more drops (as you can't see the white colour). Therefore, the colour of the juices may have interfered with when to end the titration and the results could differ between a few drops. Titration is not an accurate method to test the hypothesis, but it is easiest and the best way to do it at home with a limited amount of accurate scientific equipment and solutions.

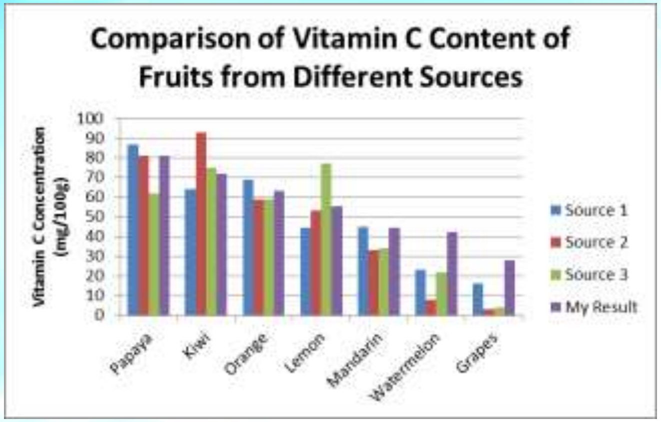
Discussion

However, even with precise, even more professional experiments, there can be some inaccuracies because the topic itself can actually vary its result a lot. This is researched after the experiment, and added further in the background information. How much vitamin C a fruit contains depends on many factors including precise variety of the plant, soil condition, climate where it grew, length of time since it was pick and stored conditions.

Discussion

These small details of a particular fruit can effect greatly on its vitamin C content. Therefore, it creates difficulty for comparison. This applies to almost all the statistics done on this. In my research, it is noted that most sources had different findings and estimations of how much vitamin C there are in fruits. But even if the numbers may vary between 5mg to 30mg, the results were mostly in the right direction and are between the large estimations. By putting this factor in consideration, my results are mostly not far off the estimations with the sources neither. My results look successful as they are similar to other sources as shown in the graph below, keeping in mind that the different species of the same fruit can give quite different results.

Graph 5: *Comparison of Vitamin C Content of Fruits from Different Sources.*



Graph 5 shows that grapes and watermelon are higher in vitamin C in my results than other sources, while the rest of the tested fruits resulted closer the estimated range. This could cause by an error of the inaccurate subjective way of judging at colour change mentioned earlier. But it can be also caused by other minor variables that are out of my reach to be controlled

Discussion

- Although it was assumed that all the fruits bought from the supermarket were fresh, this may not be the case. How ripe they are will affect their vitamin C concentration. Vitamin C content of any fruit is always higher than when it is unripe, and declines when the fruits become ripe. In my experiment, these minor variables may be not kept the same, as some fruits might be been tested ripe while others may be unripe due to its longer time spent in the supermarket. This is a possible error in the experiment.
- Improvements could be made to my experiment by buying the fruits from the same supermarket to decrease some the uncontrolled minor dependent variables such as its shelf life and stored conditions. This will heighten the accuracy more.

Discussion

The experiment was overall very successful as all the major variables that could be controlled were controlled, and my results were in a similar range compared to other sources. My method was modified from researches made before, and it worked well to answer my aim. However, I should have used less vitamin c indicator for each trial to decrease the time taken to do the whole experiment. A teaspoon of vitamin c indicator will be enough instead of a tablespoon.

What I learnt..

By doing the experiment, I understand how much vitamin C contents in each of the fruits tested –orange, watermelon, lemon, papaya, kiwi, mandarin and grapes.

I also learnt that vitamin C are very important to us. It helps to function in our body for growth, maintenance, and repair of tissues; It is also an anti-oxidant that block damages that are caused by free radicals in the body, and smokers should especially take in more vitamins from fruits such as papaya , kiwi and oranges, as they inhale tobacco smoke. I also researched about the RDA (recommended daily allowances) for Vitamin C we should intake each day. This was researched well in the background information, and this gave ideas of why I was doing this experiment.

Putting these researched information and the findings from my result, I can conclude that papayas and kiwi are fruits that contain lots of vitamin C and therefore they are good for fulfilling the RDA.

I was able to understand that many variables (such as how raw the fruits) can affect how much vitamin C there is in the fruit. Since these variables are very hard to control, results from many sources are different. With researches from many other sources, I am able to confirm that my results are within an accurate range.

Thank You For Watching