PAYA LEBAR METHODIST GIRLS' SCHOOL (SECONDARY)

To Investigate The Effect Of Different Substances on the amount Of Vitamin C in Orange Juice

By: Jodie Ong, Wong Rui Lin, Yeo LeAnn

Abstract

Our investigation was based on our personal queries of what affected Vitamin C levels in orange juice to debunk grandmother tales. We aimed to find out which substance had the biggest effect on Vitamin C levels in orange juice. Orange juice is high in Vitamin C and drank by most in the morning along with a hearty breakfast, of which is often high in salt and sugar levels. Some also like to add carbonated water into their juice to give it a sparkling aftertaste. Hence, we used the titration method with potassium iodate to determine the amount of Vitamin C in orange juice with three substances, salt, sugar and carbonated water in them. The results showed that salt decreased the amount of Vitamin C level while sugar and carbonated water caused the amount of Vitamin C to increase.

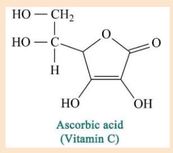
Introduction

In this investigation, we investigated on how various types of substances affected the vitamin C level in orange juice. We used a series of methods to try to find the accurate amount of vitamin C in the orange juice we tested. We used three different substances: salt, sugar and carbonated water. The method we used in the end was titration with potassium iodate. The concentration of the potassium iodate was 0.05 mol/dm^3. We chose this project mainly because of the many close relatives making the assumption that adding things into orange juice makes it healthier and increases vitamin C levels. We can find out the different types of food that should and should not be added into orange juice. Some older people who believe in myths believe in adding various substances into orange juice to increase the vitamin C level. We are able to determine if these beliefs are true and whether people should continue to practise their beliefs. Sugar, carbonated water and salt were chosen due to the stereotypical myth that adding salt and sugar can help increase levels of vitamin C as said by some of our older relatives. Carbonated water was chosen since we were curious in wanting to know if fizzy orange juice had any difference in vitamin C levels compared to regular orange juice.

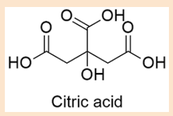
Theoretical background

1. Orange Juice

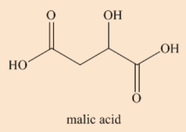
Orange juice consists of organic acids, sugars, and phenolic compounds. There are three main organic acids found in orange juice, and they are citric, malic, and ascorbic acid. The major sugars found in orange juice are sucrose, glucose, and fructose. There are approximately 13 phenolic compounds in orange juice including hydroxycinnamic acids, flavanones, hydroxybenzoic acids, hesperidin, narirutin, and ferulic acid.



Ascorbic acid (Vitamin C)



Citric acid



malic acid

2. Vitamin C structure

Vitamin C, also known as ascorbic acid has a structural formula of $C_6H_8O_6$. It consists of carbon, hydrogen and oxygen. Vitamin C is affected mainly by climate conditions, types of orange used, type of packaging, handling and storage.

3. Carbonated Water

Soda water may be identical to plain carbonated water or it may contain a small amount of table salt, sodium citrate, sodium bicarbonate, potassium bicarbonate, potassium citrate, potassium sulfate, or disodium phosphate, depending on the bottler.

Carbonated water appears to have little impact on health. While carbonated water is somewhat acidic (pH 3-4), this acidity is quickly neutralized by saliva. Soft drinks are about 100 times more erosive to teeth than sparkling mineral water.

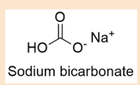
Water and carbon dioxide react together to form carbonated water : $H_2O(l) + CO_2(g) \rightleftharpoons H_2CO_3(aq)$

Carbonated water has no vitamin C and only contains carbonated water and sodium bicarbonate.

It has no protein, fat, carbohydrate, vitamins and sugar. Bicarbonate destroys vitamin C. This is due to the neutralization of the vitamin C by the sodium bicarbonate.

4. Salt (NaC*l*)

Table salt, also known as sodium chloride, NaC*l* is an ionic compound. NaC*l* is created by the reaction between sodium and chlorine.



Sodium bicarbonate

5. Sugar ($C_{12}H_{22}O_{11}$)

Sugar is a sweet substance that looks like small crystals. It can be obtained from numerous plants, such as the sugar cane and sugar beet, which consists essentially of sucrose. It is used as a sweetener in food and drink. Sugar contains carbon, hydrogen and oxygen.

Materials and Procedure

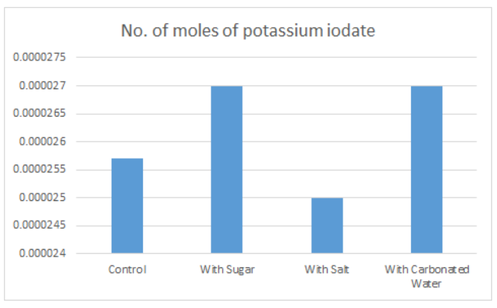
The apparatus used were a burette, burette stand and clamps, beakers, measuring cylinder, conical flasks and cheese cloths. The materials we used for this experiment includes a carton of Peel Fresh orange juice, 12 times of 25 millilitres. In total, the amount of orange juice needed varies but for most it is usually around 400 ml. Table salt, sugar, starch solution with a concentration of 0.05 mol/dm^3 and potassium iodate with a concentration of 0.01 mol/dm^3 were also used.

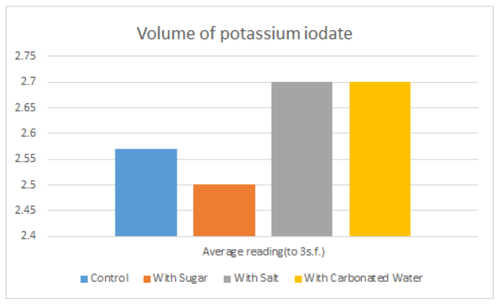
Steps:

1. Pour orange juice with pulp and filter it through a cheesecloth.
2. Pour 25 ml of orange juice, 1 ml of starch solution and 5 ml of hydrochloric acid into a conical flask and swirl to mix.
3. Prepare a burette filled with potassium iodate with a concentration of 0.01 mol/dm^3. Fill it up to the 50 ml mark.
4. Add the potassium iodate to the conical flask drip by drip and swirl while adding drip by drip.
5. Stop dripping the potassium iodate when the orange juice mixture has changed its colour. If the orange juice mixture becomes orange again after a few seconds, drip in more potassium iodate until it does not.
6. Record the reading of the potassium iodate that is shown on the burette.
7. Repeat steps 1-6 two more times in order to get an average.
8. Repeat steps 1-7 with 1 g of salt, 1 g of sugar or 25 ml of carbonated water, in the respective beakers.

Data collected

Volume of potassium iodate/cm^3	First reading / cm^3	Second reading / cm^3	Third reading / cm^3	Average reading / cm^3	No. of moles of potassium iodate
Control	2.6	2.7	2.4	2.57	2.57×10^{-5}
With Salt	2.7	2.5	2.3	2.50	2.50×10^{-5}
With Sugar	2.8	2.6	2.7	2.70	2.70×10^{-5}
With Carbonated Water	2.7	2.7	2.7	2.70	2.70×10^{-5}





Results and Discussion

Through the experiment, we used orange juice that was mixed well with salt, sugar and carbonated water. The samples were then titrated with potassium iodate with a concentration of (0.05 mol/dm^3). We repeated this experiment thrice with each new substance added into the orange juice to get an accurate result. The amount of potassium iodate that was used to turn the solution into a dark green colour was then recorded. The amount of potassium iodate recorded was then used to calculate the amount of Vitamin C present in the orange juice using the titration method.

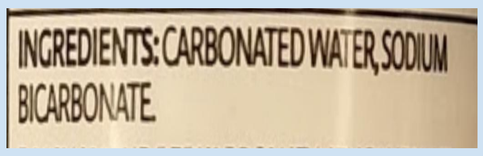
The higher the amount of potassium iodate used to turn the solutions to dark green, the higher the amount of Vitamin C present in the orange juice mixture.

Vitamin C is a polar covalent molecule due to the more electronegative oxygen atoms it has. When sodium chloride, salt, an ionic compound which has a high affinity, is added to Vitamin C, it dissociates into ions and forms electrostatic attractions with the polar Vitamin C. As a result, the structure of Vitamin C is altered, decreasing the amount of Vitamin C in the orange juice.

When sugar was added into the orange juice which has a high concentration of vitamin C, the amount of potassium iodate used to turn the mixture dark green was 2.70 cm^3. Therefore, the amount of vitamin C present is increased. This is so as the orange juice has a high concentration of vitamin C, but as the Vitamin C is not in its individual form and is mixed with other components, like proteins, water molecules and other vitamins, and sugar ($C_6H_{12}O_6$), a very good hydrolysis agent and has a low affinity. Hence, the sugar does not bond with the vitamin C and is broken away from the other components attached to it. All the ascorbic acid inside the mixture is now in the mixture. This therefore results in an increase of Vitamin C level in the orange juice mixture.

When carbonated water (H_2CO_3+$NaHCO_3$) is added into the mixture, the sodium bicarbonate in the carbonated water reacts with the orange juice. Since the orange juice is acidic with a low pH level of 3 and sodium bicarbonate is alkaline, with a high pH level of 8, the pH is balanced to the neutral pH level of 7, as the pH level of the orange juice increases from 3 to 7 and the pH level of sodium bicarbonate drops from 8-7. All the remaining ascorbic acid molecules, vitamin C, is released into the orange juice mixture. Hence, the vitamin C level increased as well.

For both the mixtures with sugar and sodium bicarbonate, 2.70 **cm^3** of potassium iodate was used to turn the orange juice mixture in the beaker to a dark green colour. This also means that the vitamin C level content in both the mixtures are equal. This is so as the same amount of orange juice has been poured into the mixture. As all the ascorbic acid has been released as it reacted with its individual substance, all the ascorbic acid in the vitamin C has been released. Therefore, the amount of vitamin C in the mixture is of its highest amount and both are equal.



Contents in carbonated water

Conclusion

Since the results have little difference, with each average differing in only a few decimals, we cannot accurately say that the substance has a change in the vitamin C in orange juice. However, from our results, we can see that sugar and carbonated water increases the amount of vitamin C in orange juice while salt decreases the amount of vitamin C in orange juice.

Bibliography

Saner, E. (2014). *How fruit juice went from health food to junk food*. *the Guardian*. Retrieved 4 April 2018, from https://www.theguardian.com/lifeandstyle/2014/jan/17/how-fruit-juice-health-food-junk-food

hydrochloric acid formula - Google Search. (2018). *Google.com.sg*. Retrieved 4 April 2018, from https://www.google.com.sg/search?ei=-nTEWv3aGsL5vATBpJ-wDg&q=hydrochloric+acid+formula&oq=hydrochloric+acid+formula&gs_l=psy-ab.3..0i67k1j0l5j0i22i30k1l4.4231.5629.0.5877.8.6.0.2.2.0.50.233.6.6.0....0...1c.1.64.psy-ab..0.8.239....0.w55PPQOJuHI

potassium iodate chemical formula - Google Search. (2018). Google.com.sg. Retrieved 4 April 2018, from https://www.google.com.sg/search?q=potassium+iodate+chemical+formulaa&oq=potassium+iodate+chemical+formulaa&aqs=chrome..69i57.8783j0j7&sourceid=chrome&ie=UTF-8

Acknowledgements

We would like to express our inaudible gratitude and thanks to our teachers in charge for their constant support and for believing in us that we would do our best, helping us whenever we needed them. We also want to show our heartfelt thanks to Dr. Subbiah Dhamodaran, Senior Research Scientist in Molecular and Health Science research industry in Singapore for guiding us through our queries.