Vitamin c deterioration in orange juice

This experimental investigation was designed to examine the deterioration of vitamin c (ascorbic acid) content when placed in conditions with different oxidization and temperature exposure. Home brand orange juice was placed in different temperatures, such as room temperature, freezer, and fridge. Also with different oxidization as one beaker from each temperature was covered with glad wrap. Over 6 weeks, mold, smells, fungi, bacteria and evaporation where just some of the observations that we made. Although, as well as observing we took test results and it was evident that freezer uncovered and freezer covered had the most content of vitamin c preserved. Over 6 weeks 8ml of orange juice was used from each beaker to test with indophenol, with most juices the juice can be added to the indophenol solution until the juice becomes clear. In some cases the orange juice won't change clear, and go a pinky brown. For this reason a control is used to compare colours. Over 6 weeks the experiment was conducted, data was collected and reached a conclusion based on the findings.

Introduction:

[4] Vitamin c is an organic compound consisting of carbon, hydrogen and oxygen, vitamin c is a water-soluble vitamin, being water-soluble this means that the body doesn't store it. Vitamin C or ascorbic acid is one of the least toxic substances and this is why vitamin c is necessary for growth and development; it helps repair tissue in all parts of the body. [10]Vitamin c helps the body make an important protein called collagen, in which is used to make skin, cartilage, tendons, ligaments and blood vessels, vitamin c is also essential for healing wounds and helping maintain and repair bones and teeth. [4] Vitamin C is also essential in an individual's health for the

maintenance of healthy connective tissue, which gives support and structure for other tissues and organs.

[5]However, the protective role of vitamin C goes far beyond our skin and gums. Cardiovascular diseases, cancers, joint diseases and cataracts are all associated with vitamin C deficiency and can be partly prevented by optimal intake of vitamin C. [6]Vitamin C achieves much of its protective effect by functioning as an antioxidant and preventing oxygen-based damage to our cells. Structures that contain fat (like the lipoprotein molecules that carry fat around our body) are particularly dependent on vitamin C for protection.

The human body uses vitamin c to complete a variety of chemical reactions, for example providing energy to cells and sending information through to neutrons. [7]Vitamin C is also very important because it metabolizes cholesterol, which means it may help lower cholesterol levels. Vitamin C is an essential nutrient responsible for manufacturing compounds and aiding in basic chemical functions. Humans must ingest vitamin C, or ascorbic acid, because we cannot make it ourselves. [11]The body gets its daily allowance of this vitamin by eating raw fruits and vegetables as part of a healthy diet.

[8]Vitamin C is needed in order to help the body to protect cells and to keep them healthy. Vitamin C is found wide variety of foods, mainly being in the fruit and vegetable areas. Good sources include:

- Broccoli
- Brussel sprouts
- Sweet potatoes
- Oranges

- Kiwi fruit
- Red berries
- Red and green bell peppers
- Tomatoes spinach
- Juices made from guava, grapefruit, and orange

Vitamin C deficiencies occur as part of general under nutrition, but severe deficiency is uncommon. Vitamin C deficiency symptoms include:

- Dry and splitting hair
- Bleeding gums
- Rough, dry, scaly skin
- Decreased wound-healing rate
- Easy bruising
- Nosebleeds
- Weakened tooth enamel
- Swollen and painful joints
- Anemia
- Decreased ability to fight infection
- Possible weight gain because of slowed metabolism

[21]A severe vitamin C deficiency is called scurvy, is a medical condition caused by a lack of vitamin C. Left untreated, scurvy can be fatal, but fortunately this condition is extremely easy to address, as all that is required to eliminate scurvy is an increase of vitamin C intake. Scurvy is relatively rare in the modern era, thanks to widespread knowledge about the need for vitamin C, but it sometimes appears in malnourished individuals, infants, and the elderly.

Early signs of scurvy include fatigue and joint pain. If the condition is allowed to progress, a distinctive rash will develop on the legs, the mucus membranes will start to bleed, former fracture sites may come apart, and the patient will experience severe muscle weakness. The lack of vitamin C allows the connective tissues of the body to essentially pull apart, allowing blood to leak freely through the blood vessels, and causing long-term damage to the muscles if the condition is not caught early. If vitamin C an individual intakes too much vitamin C it can result in stomach pain, diarrhea and flatulence.

[9]As humans cannot synthesize Vitamin C in their own bodies, there have a great need for dietary supplements of it. Although, good sources of vitamin C are fresh fruits and vegetables, especially citrus fruits. Vitamin C can also be made in a laboratory; most experts recommend getting vitamin C from a diet high in fruits and vegetables rather than taking supplements. Vitamin c supplements are effective for treatment and prevention of vitamin C deficiency, including scurvy, also these supplements are likely to be effective for improving the way the body absorbs iron and treating a disease called tyrosinemia in newborns when given as an injection.

[2]Vitamin C is safe for most people when taken by mouth in recommended doses or when applied to the skin. In some people, vitamin C might cause nausea, vomiting, heartburn, stomach cramps, headache, and other side effects. The chance of getting these side effects increases the more vitamin C you take. Amounts higher than 2000 mg per day are at risk and may cause side effects, including kidney stones and severe diarrhea. In people who

have had a kidney stone, amounts greater than 1000 mg per day greatly increase the risk of kidney stone recurrence.

[3]Vitamin C functions as an antioxidant and as a coenzyme. Molecules called free radicals are formed during normal cell metabolism. Free radicals cause damage by reacting with fats and proteins in cell membranes and genetic material. This process is called oxidation. Antioxidants like vitamin C are compounds that attach themselves to free radicals so that it is impossible for the free radical to react with, or oxidize, other molecules.

During the manufacturing stage of processing Orange juice manufacture add extra vitamin C into the liquid in order for the orange juice to deteriorate less than usual, this is also so the orange juice content abides with the label that is processed onto the packaging, this same label also states requirements after opening the juice in order when to store the juice and at what temperature. If false statements are given on the label the manufacture can face serious consequences. Therefore, the aim of this experiment is to investigate what environmental factors cause the rate of vitamin c to deteriorate quicker, with variable conditions being oxygen exposure, different temperatures and also oxidization. Our hypothesis is that the room temperature would lose vitamin c faster due to the factors of temperature oxidization.

Materials

- 2L Home brand orange juice
- 6 x250ml beakers
- 9xPipettes

- 18x Test tubes
- 3xTest tube racks
- glad wrap
- paper
- pen
- sticky take
- Indophenol solution 0. 1%
- 2xWatch glasses
- 1x scalpel

Method A

1. All materials were gathered
2. Each beaker was designated a number(1-6) which is written on a piece of paper and stuck to beaker using sticky tape
3. The beakers are then put in pairs (1-2, 3-4, 5-6)
4. Each beaker pair is then designated to an area room temperature (25degrees-37degrees), fridge (3 degrees) and freezer (-5 degrees) this is also written on the paper attached to beaker
5. 230mL of home brand orange juice was then carefully poured into each beaker
6. Each beaker was then tested with indophenol to find standard (refer to method B)
7. In each designated area (room temperature, fridge or freezer) one beaker was chosen to be covered with glad wrap making the liquid unable to breathe.
8. Each beaker was then placed in designated area and leave juices for one week

9. Gathered 18x test tubes 3x test tube rack and 9xpepits and 2x watch glasses 1x scalpel
10. Gathered all samples of juice and placed on designated safe work bench
11. Observed any noticeable changes (smells, colours, molds & fungi) and recorded in log book
12. 15 drops of indophenol was put into each test tube using a pipette
13. Using a pipette orange juice was carefully added to the indophenol solution each drop was carefully counted and swirled after each drop until a colour changed occurred.
14. Recorded how many drops in each test tube along with what designated area and covered or non-covered
15. Retested each beaker once a week by repeating steps 9-12
16. On Microsoft excel, each week data was entered in, and created a table format, with the headings, which test it was 1-6, average and standard error, with each weeks tests results (number of drops) being put under the headings 1-6 and also what it was and where (fridge uncovered.) This was done each week and a line graph was made

Method B- establishing standard

1. Placed 15 drops of indophenol solution into a test tube
2. Added 0. 1% ascorbic acid solution, one drop at a time, into the indophenol. Counted the drops added.
3. Swirled the test tube after each drop was added
4. Continued until the indophenol becomes colorless

5. What was the total number drops of 0. 1% ascorbic acid solution required to decolorize the indophenol solution.

Results

Graph no. 3- Abscorbic Acid Standard

Photo 1: Week 1 Beakers with labels

Photo 2: Week 2- Mold and fungal organisms present on room temperature covered

Photo 3: Week 3- Obvious colour change in beaker 4, water vapor present on beaker 3 and beaker 2 significant evaporation

Photo 4

Photo 5: Week 4- Change of colour in beaker 3 and 4 evaporation in beaker 2

Photo 6: 5- Obvious colour change and evaporation in beaker 1 & 2

Photo 7: Week 6-

Photo 8: Week 6- Fungal organisms in room temperature beakers

Photo 9: Week 6- Fungal organism found in beaker 3 room temperature covered

fridge covered

fridge uncovered

Room temp covered

Room temp uncovered

Freezer covered

Freezer uncovered

It is highly evident that the main trends throughout this experiment are:

- The higher the temperature the increase in level of evaporation
- The uncovered samples above freezing displayed much higher level of evaporation compared to covered samples
- The freezing samples displayed same amount of evaporation for covered and uncovered
- Orange juice becomes more intense over the content of 6 weeks due to evaporation
- Fungal organisms increase the vitamin c content

Evaporation played a major part in this experiment. Evaporation is the process of liquid turning into gas by mechanisms such as: the fastest moving molecules at the surface of the liquid have enough energy to break the attractive bonds with other molecules. They then escape the surface of the substances. Since at higher temperatures the molecules have more kinetic energy, more of them are likely to escape and so evaporation occurs more quickly at higher temperatures. The rate of evaporation is higher due to factors such as: increased temperatures, high humidity and wind exposure. [15, 16, 17]

Oxidization is a common form of chemical reaction which is the combining of oxygen with various elements and compounds; oxidation also transfers

hydrogen atoms or electrons from one molecule to another. Oxidization is a reaction in which the atoms in an element lose electrons and the valence of the element is correspondingly increased. .[12, 14]

Oxygen, the most plentiful element on earth, combines readily with numerous other elements. When combined with other elements in a compound or molecule, oxygen frequently is an electron “ hog.” It takes electrons away from many other elements and this oxidizes them. The oxygen takes the negatively charged electrons and becomes a negatively charged ion. The oxygen has been reduced. However without certain factors affecting the rate of oxidization, it can be reduced quiet significantly.[12, 13, 14]

A number of factors affect the oxidation rate, including temperature, pressure, crystal orientation, oxygen source (oxygen or water) and impurity doping. Oxide growth rate is very sensitive to temperature, because the oxygen diffusion rate in silicon dioxide is exponentially related with temperature, increasing temperature can significantly increase the oxide growth. Oxide growth rate is also related to the oxygen source. Dry oxidation with O2 has a lower oxide growth rate than wet oxidation with H2O. This is because the diffusion rate of the oxygen molecule O2 in silicon dioxide is lower than that of hydroxide HO generated from the dissociation of H2O molecules at high temperature. Therefore the wet oxidation process is preferred to grow thick oxide layers. [13, 14]

Fungi are classified within their own kingdom – The Kingdom Fungi, while some are in the Kingdom Protista. A fungus is similar to a plant, but it has no

chlorophyll and cannot make its own food like a plant can through photosynthesis. They get their food by absorbing nutrients from their surroundings. The kingdom includes the yeasts, molds, smuts, and mushrooms. Fungi must take in food materials synthesized by other organisms due to the absence of chlorophyll; the fungi cannot photosynthesize their food from simple substances. Saprophytic fungi derive food from dead and decaying materials. [18, 19, 20]

Fungi exist in various habitats, including deep down in the ocean, lakes, rocks, deserts, very salty environments, and areas of extremely high or low temperatures. However, factors such as temperature, water and light all affect the rate of fungal organisms growing. Fungi grow best in warm temperatures. Various species of fungi do grow better at warm temperatures; moreover, there are a number of fungal organisms that thrive in very high temperatures of and few that will thrive in very low temperatures below freezing. [18, 19, 20]

Fungi need lots of water to grow. For most fungi this is true. This is why fungi are more of a problem in the tropics than in temperate areas of the world. Personal property that is normally safe from fungi, such as clothing and shoes, can be damaged in the tropics. However, some fungi can grow in very dry conditions. At the other extreme, there are also fungi that can live under water. Also, fungi can only grow in the dark. For the most part, light does not play a role in how well fungi grow. [18, 19, 20]

It is evident in the results that the higher the temperature the increased level of evaporation, by viewing the outcome in the evaporation graph it can

be seen that the fridge uncovered sample evaporated 7x more than the freezer sample and the room temperature uncovered evaporated 14x more than the freezer samples. This is due to the higher temperatures in the room which increases the movement of molecules at the surfaces of the orange juice resulting in the molecules having enough energy to break the attractive bonds with other molecules, resulting in the molecules escaping the surface of the substance, and escaping into the air as water vapor.

It was apparent that room temperature uncovered sample (25-37degrees) had evaporated the most. The reason being that, this beaker was in direct sunlight, increasing the temperature and the juice temperature was increased over the other samples. This is due to the fact the molecules of a warmer liquid (room temperature) are vibrating more frequently and with more energy than in a cool liquid(freezer). The added energy of heat therefore makes it easier for a given molecule to escape the liquid.

Oxidization impacted the results significantly as the uncovered samples above freezing displayed much higher evaporation compared to covered samples. This is due the samples of uncovered beakers easier being able to obtain more oxygen; this is because the oxide growth rate growing process grows thick oxide layers within a wet or damp area. Also, the juice was subject to higher temperatures, this was because there was no layer in between the gas, to the orange juice, it is apparent that through our data the higher the temperature increases significant oxide growth.

It was demonstrated that at freezing both evaporation and oxidization had minimal affect on the samples. On the evaporation graph it is evident that

there was minimal evaporation within the both freezing samples. Both freezing samples evaporated approximately 10ml over the duration of 6 weeks. This is because the freezer temperature being at -10 degrees it would have slowed down the process of evaporation due to the fact the molecules would have been moving slower than usual and it would have had insufficient energy amount to break the attractive bonds with other molecules. Making the substance unable to escape from the liquid. At freezing it is evident there is little kinetic energy within the sample resulting in almost no evaporation and zero oxidization as both the covered and uncovered samples returned the same result.

It was evident through our data that the ascorbic acid content changed dramatically over time. The orange juice became more intense over the content of 6 weeks, with each sample ascorbic levels increasing or staying the same. This is evident in the change in % ascorbic acid content over time.

Over the duration of 6 weeks it was evident due to the results that via, oxidation and evaporation the juices became more intense with vitamin c. Not only was it oxidation and evaporation, but it also includes fungal growth. Fungal growth played a major part in the room temperature samples. Over the duration of this experiment fungal growth was observed, first sighted in week two. From the data our results showed, fungal organisms and bacteria increase the levels of vitamin c. Fungal organisms thrive in warmer conditions and of off moister this is evident in the way the fungal organisms only grew in the room temperature samples. In the warmer climate the bacteria and fungi reproduce faster and more frequent, this would increase the growth of fungal organisms within the room temperature samples.[22]

Kambucha tea is an example where fungal organisms secrete vitamin c into the drink, the drink is known as ‘ the miracle fungus.’ Kambucha tea relates to this experiment and the orange juice because, they both have vitamin c being produced into the liquid via, fungal organisms.

Our hypothesis was that room temperature would lose vitamin c the fastest, from the data and results that were produced, it is evident that the room temperature samples within the first 1-3 weeks dropped significantly, however, in week 3 there was a sudden change to the results and both room temperature samples started increasing in vitamin c content. Therefore our statement was correct for the first 1-3 weeks and then deemed incorrect for the final results of this experiment.

In conclusion, the major outcomes of this experiment are that evaporation, oxidization, and fungal organisms are all different factors that have affected the orange juice deterioration process. Temperatures and oxygen exposure also played a large role throughout this experiment. In doing this experiment again in the future, more research and prior background knowledge would have been benefited. Also, having more temperature variables would increase the data and would help in order to broaden this experiment.

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