IB Chemistry Internal Assessment

1. Topic:

Throughout the process of my Chemistry Internal Assessment I will be exploring the concept of so-called "superfoods" and whether or not they are truly as "super" as they claim to be. For the purposes of my experiment I will be looking at these super foods with regards to their concentration of vitamin C. In order to analyse the concentrations of Vitamin C to determine if the foods contain sufficient levels of vitamin C to warrant the label; superfood, I will use an iodine-based vitamin C indicator and a spectrophotometer to measure the change in transparency of the solutions to determine the vitamin C concentrations.

2. Justification for topic ("demonstrates relevance, personal significance, interest, or curiosity")

I found this topic interesting because it allows me to delve into a possible alternative to vitamin C supplements. I'm also interested to learn about how superfoods actually work and if they are as effective as they claim to be. In addition, this experiment allows me to find healthy alternatives to vitamin C supplements which I can use instead.

3. Research Question: ("relevant and fully focused")

Do "superfoods" actually contain higher levels of vitamin C than other foods?

4. Safety, ethical or environmental issues: ("full awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation")

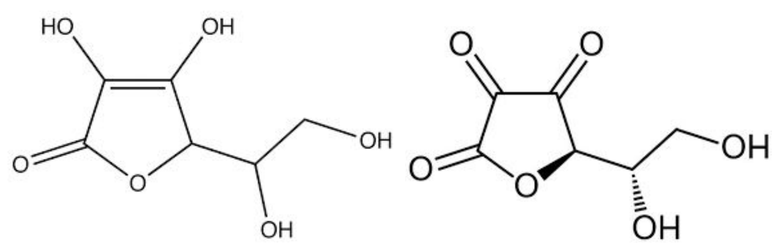
Due to the nature of the experiment and the fact that it deals with foods, the overall experiment is almost entirely safe, as long as any researchers follow basic laboratory protocol. The only dangerous substance that is used in the experiment would be the iodine solution which is hazardous if you come in direct contact with it (CDC). Other than the iodine, all of the materials in the experiment are food or food based, therefore making it very difficult for them to pose any health hazards. There are certain pieces of equipment which may be hazardous however. The most obvious safety equipment which may be hazardous would be the use of the hot plate which can cause burns if not handled carefully. The goal of the experiment is to simply analyse the concentration of Vitamin C in different foods, with no risk of harm to people, animals, or the environment. The experiment works off of a simple, iodine-based, Vitamin C indicator and the use of a spectrophotometer, neither of which pose a risk to the environment.

5. Background information with reliable resources ("appropriate, relevant, and enhances understanding of topic and approach")

Several foods in the world have been dubbed as "superfoods," and been marketed as containing more nutrients than other foods such as iron, fiber, and vitamin C. Blueberries, kale, and acai berries are all examples of foods that have been given this label. Vitamin C is among the nutrients that these superfoods are marketed as containing high levels of. Vitamin C, also known as ascorbic acid, has been proven to have numerous health benefits such as lowered risk for heart complications as well as reducing blood pressure. Many people, both men and women, don't meet their daily vitamin C requirements, and therefore turn to vitamin C supplements in order to meet this requirement (CRN). While these supplements are effective in providing the necessary vitamin C, there are several foods that have the potential to replace these supplements.

Using a vitamin C indicator, it is possible to determine the vitamin C content of different foods. This indicator works using the reaction between iodine, ascorbic acid, and starch. This method is a redox titration in which the ascorbic acid is oxidised and forms dehydroascorbic acid and the iodine is reduced to form iodide ions. Once all the ascorbic acid has been oxidised by the iodine, the excess iodine reacts with the starch forming the dark blue component of the indicator. As more ascorbic acid is added, it becomes oxidised, and once there is no excess iodine, the solution will be relatively colorless. This reaction represents the redox titration of the indicator.

$C_6H_8O_6 + I_2 \rightarrow 2I^- + C_6H_6O_6$




6. Methodology ("shows evidence of personal input and initiative; takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data; shows independent thinking, initiative, creativity, and personal input")

<u>Materials:</u>

- 1x Hot Plate

- 1x Glass Stirring Rod
- 8x Coffee Filters (For straining out fruit juice. You can use other methods but I prefer the coffee filters)
- Spectrophotometer
- 10x Spectrophotometer Cuvettes
- 1x 500 mL Erlenmeyer Flask
- 1x 200 mL Erlenmeyer Flask
- 8x 50 mL Erlenmeyer Flask (You can use less, I just preferred to have one for each sample to avoid cross-contamination and so I can compare all of the solutions side by side)
- 15x Plastic Pipettes
- 7.50g Cornstarch
- 50mL Iodine Solution
- Small Bowl
- Mortar & Pestle
- Funnel

Procedure:

Preparing the Iodine-Starch Indicator Solution:

1. Measure out 7.50g of cornstarch.
2. In a 100ml beaker, mix together the cornstarch with tap water until it forms a fine paste. (It may take less water than you think to create the paste. If too much water is added, it

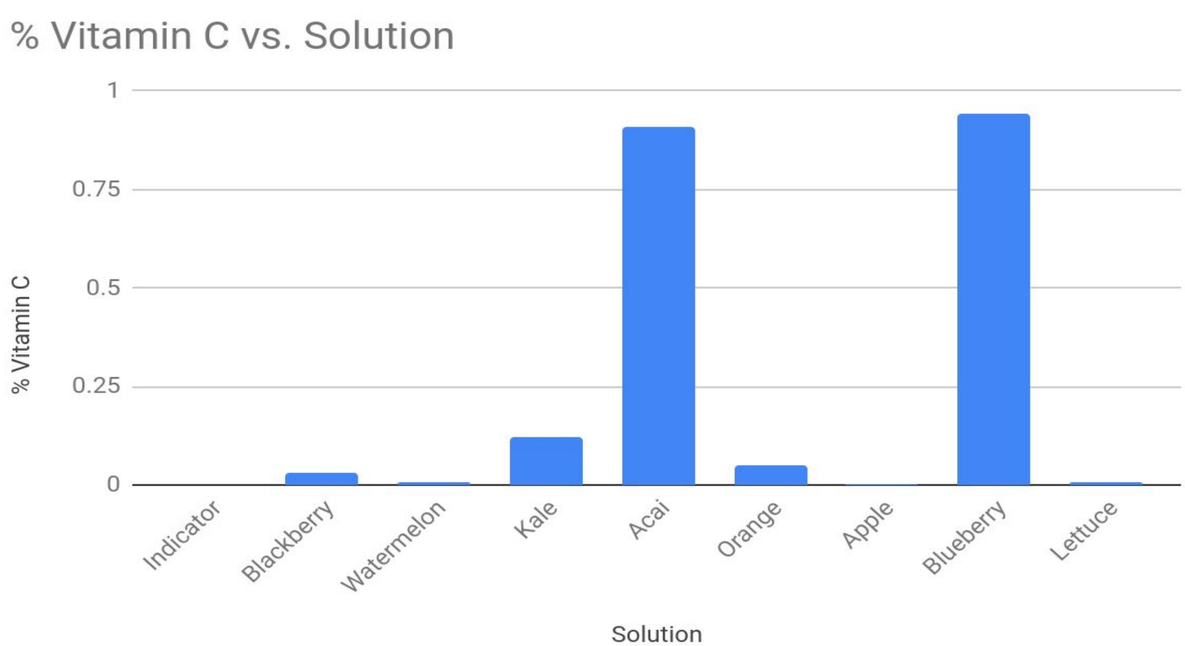
won't create a huge issue as long as you use the same sample of indicator or every experiment).

3. Measure out 250 mL of water in the 500 mL Erlenmeyer Flask. Mix in the cornstarch paste. (There may still be clumps of the paste in the solution. I found that the clumps were removed in the next step).
4. Boil the solution of water and cornstarch on the hotplate for five minutes. Remove the flask from the hotplate after the five minutes. The flask will still be hot, especially the bottom. (This removed any clumps left in the solution. You can break up the larger clumps with the glass stirring rod. As the solution boils, gases exit the flask, but since there is only water and starch in the solution, it is clear that they are not hazardous).
5. While the solution is boiling, measure out 150 mL of water in the 200 mL flask. Once the solution is done boiling, add 20 drops of the cornstarch solution to the water. The indicator is now ready.
6. Using a mortar and pestle, crush the food samples and strain them into separate containers using the coffee filters and a funnel.
7. Fill the 50 mL flasks with 20 mL of indicator solution and add 5 drops of each food solution to the flasks. The solution will become clearer with the presence of vitamin C.
8. Fill a spectrophotometer cuvette with distilled water and insert it into the machine. Set the wavelength to 500 nm and press the 0 Abs % button to blank the machine. This will reset the machine to provide more accurate readings.
9. Transfer the food solutions into the spectrophotometer and record the readings. Solutions with higher transmittance percentages have higher concentrations of vitamin C.

10. Compare the readings to the results to a spectrophotometer tube with only indicator solution (0% vitamin C). By comparing the readings from the 0% vitamin C solution and the other solutions you can calculate the percentage of vitamin C.

7. Data (“sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question”)

| | Solution Tested | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Percent Transmittance | Indicator | Black berry | Water melon | Kale | Acai Berry | Orange | Apple | Blueberry | Lettuce |
| | 33.7% | 40.6% | 37.4% | 67.4% | 81.9% | 54.4% | 42.7% | 82.3% | 39.8% |
| Percent Vitamin C | 0 | .029 | .0081 | .12 | .91 | .05 | .0046 | .94 | .009 |



8. Data Processing ("sufficient data processing is carried out with the accuracy required to enable a conclusion to the research question to be drawn that is fully consistent with the experimental data".)

The data shows that kale, acai, and blueberries have the highest vitamin C content which is consistent with the claim that these superfoods will contain higher levels of nutrients. Although the spectrophotometer is not the best way for measuring the levels of vitamin C in a substance, the results are still accurate enough to validate the results of the experiment. Compared to known results, the data is close, but not exactly the same to the data in my experiments. For example, blueberries were shown to be .94% vitamin C by my study, however in a published study by Dietitians of Canada blueberries were shown to contain .89% vitamin C.

9. Data Uncertainty ("The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis.")

Overall, the results from this experiment fall within ± .5% of published results. The slight discrepancies between the data collected and the data from further research into other studies are most likely due to the fact that the use of an iodine-starch indicator solution is not necessarily the most effective way to analyze the concentration of vitamin C in a particular substance.

10. Conclusion: ("The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced; A detailed conclusion is

described and justified which is entirely relevant to the research question and fully supported by the data presented.

Overall, it is clear that the “superfoods” which claim to contain higher levels of nutrients are in fact containing these foods. However, I was surprised by the fact that oranges did not contain a higher level of vitamin C. Overall, the experiment proved the claim that “superfoods” contain higher levels of nutrients, specifically vitamin C. The data supports this by showing clearly a higher percentage of vitamin C than the other foods that I tested. In conclusion, superfoods contain significantly higher levels of vitamin C than normal foods.

11. Self reflection: assess yourself after reading your IA, make any changes needed, then check each item:

_____”The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.”

_____”The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. “

_____”The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. “

_____”The use of subject specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.”

“Americans Do Not Get All the Nutrients They Need From Food.” *Council for Responsible Nutrition*, www.crnusa.org/resources/americans-do-not-get-all-nutrients-they-need-food.

"Determination of Vitamin C Concentration by Titration." *University of Canterbury*, www.canterbury.ac.nz/media/documents/science-outreach/vitaminc_iodine.pdf.

"Trace Elements: Iodine." *Centers for Disease Control and Prevention*, www.cdc.gov/nutritionreport/99-02/pdf/nr_ch4a.pdf.

"Vitamin C: MedlinePlus Medical Encyclopedia." *MedlinePlus*, U.S. National Library of Medicine, medlineplus.gov/ency/article/002404.htm.

https://www.dietitians.ca/Downloads/Factsheets/Food-Sources-of-Vitamin-C.aspx