

Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Investigation)

(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: SBBC113

Project Title: The Destroyer of Vitamin C

Project Type: Investigation

*To our best knowledge, there are / are no * similar works in the field; (if there are,) related research links are as below:*

The enhancement our project made / the difference with related research are:

**Please delete if not applicable. The competition values the originality of works. Students must do enough literature research to ensure that their works are unique and list relevant reference materials before starting research or invention.*

I. Background

With the recent rising awareness towards health issues among society, many prefer eating 'light' nowadays- such as eating salad instead of rice and meat so as to maximise their intake of nutrients, such as Vitamin C, with the lowest fats. However, there is a hearsay that the content of vitamins in food decreases when consumed with cucumbers.

II. Objectives

We aim to investigate the decrease in vitamin C content when vitamin C containing products are stored under different conditions and when it is consumed with other vegetables (e.g. in salad).

III. Hypothesis

Substances in cucumber eg. Enzymes, which is believed to be L-ascorbate oxidase, could denature the vitamin C (ascorbic acid) in food, resulting in a decrease in the amount of vitamin C when it comes into contact with cucumber.

IV. Methodology

To study the effect of cucumber on vitamin C, we must first investigate the natural degradation of vitamin C without the effects of cucumber.
DCPIP solution is a food test commonly used to study the concentration of vitamin C. It gives an observable colour change when all the DCPIP is reacted with vitamin C. It is a quantitative food test suitable for our investigation. Titration of vitamin C against DCPIP solution is adopted to determine the relative concentration of vitamin C in the sample.

V. Results

Table 1. Loss in content of vitamin C in diluted solution stored in room condition

Vitamin C concentration: 1000mg/200mL then diluted 50x,
ie. 1000mg/200mL -> 10mg/100mL

<u>After 0 hr</u>	Volume of diluted vitamin C solution needed to titrate against 25mL of 0.1 % DCPIP solution
Avg	23.5

Table 1a.

<u>After 3 hr</u>	Volume of diluted vitamin C solution needed to titrate against 25mL of 0.1 % DCPIP solution
Avg	50.9

Table 1b.

With reference to online resource, 1cm³ of 0.1% DCPIP solution require 6.071×10^{-4} g ascorbic acid. Therefore, $25 \times 6.071 \times 10^{-4}$ g ascorbic acid is found in 23.5 mL of 0 hr vitamin C sample. The concentration is 0.646 mg/mL.

After 3 hours, the concentration become 0.298 mg/mL. There is a 53.8% decrease in vitamin C concentration.

Therefore, the longer the sample is placed under normal room conditions, the higher the amount of vitamin C loss is.

Table 2. Loss in content of vitamin C in diluted solution stored in ice bath and blocked from light

<u>After 3 hr</u>	Volume of diluted vitamin C solution stored in ice bath and blocked from light needed to titrate against 25mL of 0.1 % DCPIP solution
Avg	27.5

By storing vitamin C solution at a low temperature and dim environment, the loss of vitamin C content can be lowered. This storing method is used throughout the experiment so that the vitamin C concentration can be kept constant between titration trials, as titration is a time-consuming process.

In the experiment, titration is used to test the amount and concentration of vitamin C under different conditions required to turn DCPIP solution (test for vitamin C) from blue to colourless.

Table 3. Loss in content of vitamin C in concentrated solution stored in room conditions for 24 hours before dilution

24 hr (50x dilution is done after 24 hr)	Volume of diluted vitamin C solution needed to titrate against 25mL of 0.1 % DCPIP solution
1 st trial	27.0
2 nd trial	26.9
3 rd trial	26.8
Avg	26.9

The loss of vitamin C content from the solution under room condition is insignificant if the Vitamin C solution is kept concentrated before the dilution and test. Therefore, the dilution of the Vitamin C solution would be done respectively right before each of the following experiments so that we can ensure that any change in vitamin C concentration is caused by the presence of cucumber/ cucumber juice.

Table 4. Loss in content of vitamin C when diluted vitamin C solution is mixed with cucumber slices and cucumber juice respectively

Vitamin C concentration: **10mg/100mL (diluted)**

	Cucumber (in slices)	Blended cucumber	Control (no cucumber, data from the first table above)
0 hr	>100	36.8	23.5
0.5 hr	>100	>100 (infinite)	/

*solution is kept in ice bath and dim environment

It is shown that the rate of loss in vitamin C content is significantly higher when the sample is mixed with cucumber slices than with cucumber juice. One of the possible factors for this phenomenon is the difference in the surface area of cucumber in the two setups. For the sliced cucumber, the surface area exposed to the vitamin C sample is smaller than that of the fully blended cucumber. More enzymes are allowed to react with and catalyse the breakdown of ascorbic acid, ie. lowering the sample's vitamin C content.

Table 5. Loss in content of vitamin C when concentrated vitamin C solution is mixed with cucumber slices and cucumber juice respectively

Vitamin C concentration: **1000mg/200mL (concentrated)**

	Cucumber (in slices)	Blended cucumber	Control (no cucumber, data from Table 1 above)
0 hr	1.4 (164%)	0.5 (460%)	0.4
15 mins	1.2 (192%)	0.6 (383%)	0.4
30 mins	1.4 (164%)		0.4
45 mins	1.2 (192%)	0.4 (575%)	0.4

60 mins	1.1 (209%)	0.5 (460%)	0.4
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(): relative vitamin C concentration

Overall, when cucumber is added to concentrated vitamin C solution, there is no significant change in vitamin C concentration. When concentrated vitamin C solution is used, there is very little effect on the vitamin C concentration by cucumber. Compared to the Vitamin C solution mixed with blended cucumber, the effect on vitamin C concentration by not-blended cucumber is less significant.

This could be due to the strong intermolecular force between ascorbic acid molecules under concentrated conditions, such that the enzyme in cucumber is not enough to break down the ascorbic acid molecules.

Table 6. Loss in content of vitamin C when diluted vitamin C solution is mixed with boiled cucumber slices (10 mins in boiling water)

Vitamin C concentration: **10mg/100mL**

	Blend	No blend	Control (no cucumber, data from the first table above)
0 hr	37.8	26.4	23.5

When cucumber is boiled in water (above the optimum temperature to store cucumber), the structure of the enzyme - L-ascorbate oxidase is denatured due to high temperature. Therefore, when the boiled cucumber is added to dilute vitamin C solution, the volume of solution (diluted vitamin C solution mixes with boiled cucumber) needed to turn DCPIP solution from blue to colourless will be similar as the result before the cucumber is added. In other words, the decrease in vitamin C concentration in the solution is not significant.

*The difference between blend and no blend is explained by the extra water added for blending, which diluted the vitamin C solution.

VI. If your team will compete the Sustainable Development Award, please indicate the specific sustainable development goal the project is related to, and provide justification for competing for this award. (Word limit: 300 words)

Good health and well-being. Our project promote proper consumption and preservation of vitamin C. This can allow citizen to intake sufficient vitamin C and meet their daily vitamin C requirement. This help lower the risk of having deficiency diseases.

VII. If your team will compete the Social Innovation Award, please list the target group or social issue the project focuses on, and provide justification for competing for this award.

(Word limit: 300 words)

VIII. Conclusion

cucumber contains a substance which reduces the amount of vitamin C in other food once they come into contact.

The effect is eliminated when the vitamin C concentration is high and when the cucumber is boiled. Vitamin C is also preserved when stored in cold and dark environment.

Our project is developed based on previous project and the enhancement is below: