Determination of Ascorbic Acid in Commercial Fruit Juices Using an Iodometric Titration Method

Youngsub Lee 22755152

Abstract

In this observational study, the relative quantity of ascorbic acid present in fruit (apple, orange, cranberry, and grape) juices was determined using an analysis of redox titration involving an iodometric method. The titration was conducted three times per each treatment and the identification of the endpoint in titration was determined using starch as a visual indicator. In our result, apple juice (4.8 mg / 10 mL) had the highest amount of vitamin C present followed by orange juice (4.0 mg / 10 mL), grape juice (2.2 mg / 10 mL), and (2.0   21mg / 10 mL) cranberry juice. As this experiment was conducted at home-setting, we propose that there are many sources of error and need of improvement. Therefore, it is recommended that for the future studies to conduct this experiment in a laboratory setting with access to precise measurement equipment. No hypothesis was stated for this observational research.

1. Introduction

Ascorbic acid, vitamin C, is an essential antioxidant that plays an important role in numerous biological activities such as formation of collagen and absorption of iron (Mo, Liu, Gao, Zhao, & Shao, 2018). As humans are unable to synthesize ascorbic acid, it is important to meet recommended daily amounts for ascorbic acid with the right diet containing ascorbic acid (Spínola, Mendes, Câmara, & Castilho, 2013). Ascorbic acid is used as an antioxidant for soft drinks and medicine for liver disease, drug poisoning and scurvy (de Quirós, Fernández-Arias, & López-Hernández, 2009). Ascorbic acid is often taken as a vitamin supplement to boost immunity. However, overdose on ascorbic acid can cause undesirable effects such as diarrhoea, nausea, and side-effects, (cite-screen). Therefore, the determination of the quantity of vitamin C in foods and beverages is important (Matos, Augelli, Pedrotti, Lago, & Angnes, 1998).

Objective of this study was to determine the amount of ascorbic acid in fruit juices using an iodometric titration method. As the iodine is added during the titration, the ascorbic acid is oxidized to dehydroascorbic acid, while the iodine is reduced to iodide ions. Iodine will be reduced to iodide until all the ascorbic acid in the solution is used up. Once all the ascorbic acid is oxidized, the excess iodine added will react with the starch indicator resulting in dark blue colour, dictating the end-point of the titration (Silva, Simoni, Collins, & Volpe, 1999). Hence, the amount of iodine added during the titration can inform the amount of ascorbic acid present in different fruit juice.

2. Method

2.1 Preparation of a calibrated vitamin C solution

A vitamin C tablet (1000 mg) was grinded and dissolved into 1 L of cool tap water.

2.2 Preparation of a starch indicator solution

A teaspoon of corn flour was poured into a plastic cup. Then boiling water was poured to fill ¾ of the cup.

2.3 Procedure

10mL of calibrated vitamin C solution and 5 mL of starch were poured into a plastic cup containing 100mL of water. Then this solution was titrated with 2.5% iodine tincture until the permanent dark-blue colour was observed. Different end-point colours were expected for commercial juice during the titration. The plastic cup was swirled after each drop of iodine was added to the solution. The titration was repeated three times. This process was repeated using apple, orange, cranberry, and grape fruit juice. The observation table containing the titration results was created. Each drop of iodine was regarded as 0.05 mL.

2.4 Sample calculation for Table. 1 (Pathy, 2018)

10 mL of ascorbic acid solution from 1 L of prepared solution of 1000 mg ascorbic acid. Hence, 10 mg of ascorbic acid is in the calibrated ascorbic acid solution and 1.57 mL of iodine is used to reach the endpoint.

31 drops of iodine was added to reach the endpoint of the calibrated ascorbic acid solution.
31 drops of iodine x 0.05 mL = 1.55 mL of iodine. Average calculation of the calibrated ascorbic acid solution: (1.55 mL + 1.55 mL + 1.60 mL) / 3 = 1.57 mL

2.5 Sample calculation for Table. 2 (Pathy, 2018)

Taking account that 1 mole of iodine reacts with 1 mole of ascorbic acid,

$$\text{Mole of iodine } = \frac{\text{Mass of ascorbic acid}}{Molar\ mass\ of\ ascorbic\ acid}$$

Mole of iodine = $0.01\ g\ Ascorbic\ acid\ x \frac{1\ mol\ ascorbic\ acid}{176.12 g} = 0.000057\ mol$

Mass of ascorbic acid =
$Mole\ of\ iodine\ x\ volume\ of\ iodine\ x\ molar\ mass\ of\ ascorbic\ acid$

$0.000057\ mol\ x\ 1.57\ mL\ x\ 176.12\ g = 0.0157\ g$ = 15.7 mg in 10 mL of ascorbic acid

3. Result & Discussion

Table 1. Observation and data table for iodometric titration.

Treatments (10 mL)	Amount of Iodine added: Trial #1	Amount of Iodine added: Trial #2	Amount of Iodine added: Trial #3	Average amount (mL) of Iodine Used	Observation of the end-point
Calibrated ascorbic acid solution	1.55 mL	1.55 mL	1.60 mL	1.57 mL	From white to dark blue
Apple juice	0.50 mL	0.50 mL	0.45 mL	0.48 mL	From yellow to light green
Orange juice	0.40 mL	0.40 mL	0.40 mL	0.40 mL	From yellow to dark green
Cranberry juice	0.20 mL	0.20 mL	0.20 mL	0.20 mL	From dark red to purple black
Grape juice	0.20 mL	0.25 mL	0.20 mL	0.22 mL	From orange to light green

Table 2. Determination of the quantity of ascorbic acid in fruit juices by iodometric titration method.

Treatments	Amount of ascorbic acid/10 mL
Calibrated ascorbic acid solution	15.7 mg
Apple juice	4.8 mg
Orange juice	4.0 mg
Cranberry juice	2.0 mg
Grape juice	2.2 mg

Determination of the amount of ascorbic acid using iodometric titration method illustrated that the average ascorbic acid is highest in apple juice followed by orange juice, grape juice and cranberry juice and the ascorbic acid is found to be 15.7 mg/10 ml, 4.8 mg/10 ml, 4.0 mg/10 ml, 2.2 mg/10 ml, and 2.0 mg/10 ml respectively. The endpoint of iodometric titration indicated the presence of ascorbic acid in all the fruit juice samples. It was known that the higher volume of iodine is needed if there is a higher amount of ascorbic acid. The result was consistent with the amount of ascorbic acid labeled by the fruit juices. For example, the highest amount of ascorbic acid was expected to be found in apple juice, followed by orange juice, cranberry juice and grape juice based on the nutrient labels.

However, the amount of ascorbic acid present in the fruit juices obtained from this research was lower than the stated value of ascorbic acid on the fruit juices while it was found that there is a higher amount of ascorbic acid in the vitamin C tablet. There were limitations and source of errors that may have contributed to this discrepancies in the results. The concentration of ascorbic acid can be affected by the temperature and presence or absence of light (Shrestha, Shrestha, & Bhattarai, 2016). Also, the ascorbic acid content may vary based on the type and duration of storage (Shrestha, Shrestha, & Bhattarai, 2016). In this experiment, the date of purchase of fruit juices was different which may have influenced the amount of ascorbic acid present in the juices due to the differences in storage period. Another source of error may be due to susceptibility of ascorbic acid to oxidation by atmospheric oxygen over time. Hence, fruit juice samples need to be prepared immediately before the titration (Pathy, 2018). However, in this home-lab experiment, fruit juices were exposed to oxygen numerous times as they were previously utilized. It is recommended to properly address these physical factors into consideration by maintaining controlled conditions for different samples.

Moreover, there was a possibility of human error which may have decreased the accuracy and precision of the results as the equipment for iodometric titration method was limited. It was noted that the dropper used to add iodine during the experiment had inconsistent volume of transfer. Each drop of iodine was eyeballed and estimated as an approximate volume of 0.05 mL. We believe that this was one of the key sources of error. For the future experiment on iodometric titration, we strongly suggest it to be performed in a laboratory setting with proper designed tools for accurate detection of endpoints and conduct statistical analysis for reliable results.

4. Conclusion

Ascorbic acid can be found from many fruits and commercial beverages. Iodometric titration method was used to determine the amount of ascorbic acid in different fruit juices. Determining the accurate and precise amount of ascorbic acid present in fruit juices requires proper laboratory equipment while taking physical factors such as temperature and light into a control.

5. Literature

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