Vitamin C Content of Emergen-C and Airborne Prepared with Hot and Cold Water

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Abstract
Supplementation of vitamin C (ascorbic acid) has been used for centuries to promote immune system health and to ward off various illnesses such as scurvy, and the common cold. While scurvy has become largely obsolete with increased levels of vitamin C in our foods, it is still commonplace to supplement one’s dietary intake in an effort to prevent the cold virus or lessen its duration and severity.

While the concept of vitamin C supplementation has largely changed, the form it takes has evolved. For consumers wishing to prevent or lessen cold symptoms, vitamin C drink mixtures have become the method of choice over the last few decades, likely for reasons of convenience. Little attention has been focused on variables that might affect the potency of the supplement, and thus its efficacy. Due to the known heat-degradation of nutrients like vitamin C it must be known whether preparation temperature affects the concentration or not.

Two brands of vitamin C drink-mix supplement were obtained and tested at the two water temperatures most likely to be used by the consumer: room-temperature (23°C) and hot water (70°C). An indophenol method was employed to quantify the vitamin C content after preparation per package directions, as a typical consumer would. Dye was administered to the sample by burette until a sustained pink hue had been achieved. The volume of dye necessary to facilitate this change is directly related to vitamin C content, and so this factor was of primary concern. Results indicate that there is likely no difference between hot and room-temperature preparations. Across both brands neither showed statistically significant difference, with the Airborne room-temperature and hot samples were even closer in value, at 1.075 g and 1.061 g total ascorbic acid content, a difference of just 0.004 g which is statistically insignificant.

Introduction
• Vitamin C is an essential component in our diet because it is a required ingredient for many body processes.
• Vitamin C is a cofactor for many different enzymatic reactions in the body, and also well known as an antioxidant and immunity aid. The name vitamin C refers to the L- enantiomer of the ascorbic acid (pictured below), as well as its oxidized forms.
• Fresh fruits and vegetables are the best sources of Vitamin C. Some of the foods that have the highest source of Vitamin C include red and green peppers, and oranges.
• It is recommended, that in order to get the most vitamin C out of the foods as possible, they should be eaten raw. This is because Vitamin C is very unstable and susceptible to being destroyed by light, heat, and exposure to oxygen.
• The objective of this study was to determine if vitamin C supplements that are to be dissolved in water have a higher vitamin C content in room temperature water or in hot water.
• It was hypothesized that the hot water solution will degrade the vitamin C, and so the ambient water solution will contain more vitamin C.

Materials & Method
• Reagents: Indophenol Solution, Metaphosphoric acid-acetic acid solution, ascorbic acid standard
• Samples: Emergen-C, Airborne
• Burette and burette stand
• Hot plate, thermometer, stopwatch
• Erlenmeyer flasks, 50, 250 ml volumetric flasks, auto-pipettes, analytical balance

Indophenol Solution: Titration solution
• 42 mg of sodium bicharbonate and 50 mg of 2, 6-dichlorindophenol
• 7.5 g of ascorbic acid was dissolved in 50 ml distilled water, then diluted to 200 ml

Metaphosphoric acid-acetic acid solution (MPAA)
• 20 ml of acetic acid was mixed with 100 ml distilled water
• 7.5 g of metaphosphoric acid was then dissolved in the acetic acid solution

Ascorbic acid standard solution
• 50 mg of ascorbic acid was dissolved with distilled water in a 50 ml volumetric flask

Standardization of dye: Done in triplicates
• 2 ml of ascorbic acid standard solution was added to 5 ml MPAA solution
• Titration with indophenol solution until endpoint

Blank Titrations: Done in triplicates
• 7 ml of MPAA was added to a volume of distilled water that is approximately equal to the volume of dye used to titrate the standard sample

Supplement Samples Preparation: Contents of one Emergen-C packet & 1 tablet of Airborne
• Each supplement was dissolved in 5 oz of cool water (~23°C)
• Each supplement was dissolved in 5 oz of hot water (~70°C)

Sample Titrations: Done in triplicates
• 0.25 ml of sample was added to 5 ml of MPAA solution
• Titration with indophenol solution until endpoint

Results were recorded and the data analyzed.

Discussion & Conclusion
Before testing of the supplement samples, an ascorbic acid standard and blank samples were produced, in order to correct for possible calibration error (Table 1). Both the ascorbic acid standard samples and blanks had remarkable precision, each reading being identical to its counterparts in its respective category, yielding standard deviations of 0.00 and CV values of 0.00% as well. This indicates that the method being used is indeed valid and capable of producing accurate results. Supplement samples were divided in a 2-by-2 factorial fashion, each brand being represented by samples of both temperatures (23°C and 70°C) as seen in Table 2. Mean dye volume needed for complete reaction ranged from 13.23 mL to 13.56 mL, a difference of 0.33 mL. Whether compared by brand or temperature no significant difference could be elucidated, indicating that temperature has no discernible effect on vitamin C content. An R² value of 0.3039 and a linear slope of near zero (0.002) both support the notion of non-correlation (Figure 1), that the control variable exerted no determinable effect on the dependent variable.

As evidenced by the resulting data, it can be stated with confidence that the temperature of preparation has no effect on vitamin C content in drink-mix supplements at the tested temperature range. Vitamin C content in each sample was nearly identical regardless of temperature or brand indicating that consumers are able to ingest the supplement at the temperature of their preference without vitamin-loss. The results warrant further study of this dynamic at expanded temperature ranges to determine whether there is correlation at more extreme temperatures.

Table 1. Titrant volume and analysis of ascorbic acid and blank samples

<table>
<thead>
<tr>
<th>Trial</th>
<th>Titrant Vol. (mL)</th>
<th>Titrant Vol. (mL)</th>
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<tbody>
<tr>
<td>1</td>
<td>12.7</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>12.7</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>12.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Mean</td>
<td>12.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>CV</td>
<td>0.00%</td>
<td>0.00%</td>
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</table>

Table 2. Vitamin C supplement sample titration data and analysis

<table>
<thead>
<tr>
<th>Trial</th>
<th>Titrant Vol. (mL)</th>
<th>Titrant Vol. (mL)</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>Emergen-C</td>
<td>1.72</td>
<td>12.70%</td>
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References