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Determination of vitamin C content in peaches at different stages of maturity

Choucranie N. Kayembe

ABSTRACT

The goal of this research is to quantify the vitamin C (ascorbic acid) content of peaches at 3 stages of maturity: before ripening, ripened and over ripened and then to analyze the influence of the peel of the fruit on the total vitamin C content. Many studies have been conducted on the vitamin C content of fruits but only a few of them talks about peaches despite its popularity. We performed an iodine titration as our method of determination of the vitamin C content of peaches and concluded that the maturity stage of the fruits plays an important role in its vitamin C content while the presence/absence of peel did not make a significant difference.

Keywords: *ascorbic acid, iodine solution, peaches, redox titration, vitamin C*

INTRODUCTION

Vitamin C, also known as L-ascorbic acid, is an essential micronutrient for humans that is mainly found in fruits and vegetables. Chemically, vitamin C is the simplest of vitamins and therefore it was among the first vitamins to be discovered, characterized, and purified (Davies, 2007).

Vitamin C is an electron donor and many of its known functions for human health are based on that property. Indeed, as an electron donor, it is an effective water-soluble antioxidant in humans (Sebastian 2013) because it is able to act both directly by reaction with aqueous peroxyl radicals or indirectly by repairing the antioxidant properties of fat-soluble vitamin E (Bendich, 2007).

As stated above, fruits and vegetables are the best source of vitamin C. According to the National Institute of health (NIH), citrus fruits, tomato juice and potatoes are the major providers of vitamin to American diet. Prolonged storage and some cooking methods are known to considerably decrease the amount of vitamin C as it is water soluble and destroyed by heat (Weinstein, 2001). Luckily, the majority of the best sources of vitamin C, such as fruits and vegetables, are often consumed raw.

As people grow old the dietary requirements of vitamin C increases (Journal of the American Dietetic Association, 1994). The current state of knowledge relating to its properties and physiological actions in our daily life increases everyday as new researches about it are done. That is because ascorbic is crucial for countless different processes in the human body and health benefits of vitamin C are no longer to discuss. For example, ascorbic acid is known to support the immune system defense by helping numerous cellular functions of both the adaptive and innate immune system (Anitra, 2017). Not only that but it also contributes to the support of the epithelial barrier function by blocking pathogens and stimulates the antioxidant activity of the skin. According to some studies, high intakes of vitamin C are linked to a reduced risk of some types of cancer such as the gastrointestinal tract, including the mouth, pharynx, esophagus, stomach, and pancreas cancer (Broihier, 1998). Thousands of tons of L-ascorbic acid are produced every year as it is extensively used in food industry (Davies, 2007) and even though we know a lot about its benefit for human its exact mechanism of actions is still unknown due to the lack of appropriate systems (Zawada, 2016).

Peaches may not be among the fruits that present the highest content of vitamin C, but they are considered as the queen of fruits (Habib, 2015). Peaches culture dates back at least 4000 years ago. It was highly cultivated in Shanghai, China in late imperial times (Swislocki, 2008) and it is still important fruit in the Chinese culture as it represents immortality.

Peaches present many health benefits that include the relief from hypokalemia, some cancers, obesity, cholesterol, and blood stasis and neurodegenerative diseases (Habib, 2015). Some of these health benefits can be matched with those of Vitamin C discussed above. The maturation stages of peaches can now be observed by using a small device for in-loco application (orchard) for maturation phase analysis which can create a fast and precise response to the growth cycle of peaches (Voss, 2019).

Through this research, I was curious to observe how the amount of vitamin C varies throughout the fruit maturation and see if the peel of the fruit also contributes to its ascorbic acid content. I believe that observing the change in the vitamin C concentration in peaches overtime will be useful to the scientific community as vitamin C content has become a huge subject in the biochemistry field and commercial food (Phillips, 2015) because of its huge role in human health. The aim of this work is to explain, analyze

and observe the vitamin C content in peaches at their different stages of maturation with and without their peel. In addition, it will be interesting to work with fisheries first for informational purposes and secondly because it is a popular fruit among consumers. This can therefore help and motivate national brands to grow their product to the best of their nutritional content.

MATERIALS AND METHODS

For this experiment we used peaches obtained from the farm of Medora local market, McPherson, KS. We selected 15 peaches at three maturity stages: before ripening, ripened and over ripened. They were five peaches in each set.

Sample preparation

Peaches were carefully cleaned with distilled deionized water to avoid any risk of contamination. Each fruit was cut into two equals halves while one half was used for the study with peel and the other one peeled. After that, each half was pulverized separately using a blender. Each blended fruit sample was filtered using a cheesecloth and transferred into a labeled container and frozen until the titration.

Starch and iodine solution preparation

To prepare the iodine solution, we mixed 2 g of potassium and 1.3 g of iodine solution into a beaker. We added a few mL of distilled water to the beaker to dissolve the iodine and then we transferred the iodine solution into a 1 L volumetric flask and diluted it up to the 1 L mark using distilled deionized water.

For the starch solution, we used 0.25 g of soluble starch and added 50 mL of boiling water to it. We dissolved most of the starch by stirring the mixture and let the mixture cool down before using it for the titration.

Titrations

A redox titration was conducted using 0.005 molar iodine solution as the titrant. For each titration we pipetted 20 mL of sample solution and added 150 mL of DI water and 1 mL of starch indicator. The solution was titrated with the iodine solution and the endpoint of the titration was characterized by the first constant brownish color. Using the average volume of iodine solution. We calculated the number of moles of ascorbic acid in the reaction and derived its corresponding concentration.

Calculations method

We used the concordant titres to calculate the average volume of iodine solution. We calculated the number of moles of iodine reacting. We used the equation of the titration to determine the number of moles of vitamin C reacting. We calculated the vitamin C concentration of our sample in mol L^{-1} and in mg/100g of fruit.

RESULTS

Table 1. Average vitamin C concentration in mg per 100g of peaches at the three stages studied, with/without peel.

	Stage 1: before ripening		Stage 2: ripened		Stage 3: over ripened	
Peel (P) No Peel (NP)	P	NP	P	NP	P	NP
Average [vit C] in mg/100g	56.28	62.17	79.91	77.59	72.85	68.81

This table shows that the maturity stage of the fruits as a significant impact in its vitamin C content while the presence/absence of peel does not show a to affect much the ascorbic acid content.

Table 2. Results of the two-way ANOVA test

Source	df	SS	MS	F	p-value
Stage	2	1928.40	964.200	3.55	0.045
Peel	1	0.19	0.19	0.00068	0.979
Stage x peel	2	140.93	70.47	0.26	0.774
Residual	24	6523.65	271.82		
total	29	8593.16	296.32		

Based on the results above and the p-values, we observe that the difference in the mean values among the different levels of Stage is greater than would be expected by chance after allowing for effects of differences in peel. There is a statistically significant difference (P = 0.045). The difference in the mean values among the different levels of peel is not great enough to exclude the possibility that the difference is just due to random sampling variability after allowing for the effects of differences in Stage. There is not a statistically significant difference (P = 0.979). The effect of different levels of Stage does not depend on what level of peel is present. There is not a statistically significant interaction between Stage and peel (P = 0.774).

DISCUSSION

For the experiment we determined the vitamin C concentration of our samples by performing a redox titration using iodine and starch solution. Iodine being relatively insoluble, we mixed it with iodide in order to

form triiodide:

$$I_2 + I^- \leftrightarrow I^-_3$$

This triiodide oxidizes ascorbic acid to dehydro-ascorbic acid:

$$C_6H_8O_6 + I_3^- + H_2O \rightarrow C_6H_6O_6 + 3\ I^- + 2H^+$$

As long as the solution contains vitamin C, triiodide continue to be converted into iodide ion. However, once all the vitamin C is oxidized, the iodine starts reacting with the starch present in solution forming a blue-black starch-iodine complex. That change of color indicates the endpoint of the titration. In our case, the endpoint had a brownish color.

Based on the results, it has been concluded that each of the stages was significantly different from the other two stages (stage 1 vs stage 2 showed the most significant difference). Also based on the results, it has been noted that the peel versus no peel factor did not make any significant difference on the total concentration of vitamin C in the fruit.

As explained in the sections above, vitamin C is a really important micronutrient that helps to support the immune system defense using many cellular functions of both the adaptive and innate immune system. Ascorbic acid is also known to contribute to the support of the epithelial barrier function by blocking pathogens and stimulates the antioxidant activity of the skin. High intakes of vitamin C are linked to a reduced risk of some types of cancer such as the gastrointestinal tract, including the mouth, pharynx, esophagus, stomach, and pancreas cancer.

The aim of this work was to observe how the amount of vitamin C varies throughout the fruit maturation and see if the peel of the fruit also contributes to its ascorbic acid content. We then try to explain, analyze, and observe the vitamin C content in peaches at their different stages of maturation with and without their peel.

We used peaches obtained from the farm of Medora local market, McPherson, and performed a redox titration using iodine solution. The solution was titrated with the iodine solution and the endpoint of the titration was characterized by the first constant brownish color.

As I expected it, the vitamin C concentration increased as the fruit matured.

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