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Quantitative determination of ascorbic acid content in some fruit peels obtained in Ado-Ekiti by redox titration

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Abstract

Fruits contains peels which are discarded when these fruits are being consumed. The research work was based on quantitative determination of Ascorbic acid (AA) contents of six different fruit peels purchased from local market of Ado-Ekiti, Ekiti State, Nigeria. The procedure and the calculation is based on iodometric titration where dark blue complex forms in the presence of starch. The ascorbic acid contents of the fruit peels studies were grape, lemon, watermelon, orange and pineapple. The results showed that fruit peels from pineapple (22.7gcm-3) has the highest amount of ascorbic acid/ vitamin C which means that the wasted parts of some fruit peels most especially pineapple peels contain appreciable amount of vitamin C. Therefore, prudent use of by-products from the wasted part of some fruits can also be helpful to achieve daily recommended dose of vitamin C and at the same time assist in waste management and pollution control.

Keywords: Ascorbic acid; Iodometric titration; Fruit peels; Redox titration and Iodine

1. Introduction

Vitamin C (also known as ascorbic acid and ascorbate) is a water-soluble vitamin found in various foods and sold as a dietary supplement. It is used to prevent and treat scurvy. It is an essential nutrient involved in the repair of tissue, the formation of collagen, and the enzymatic production of certain neurotransmitters. It is required for the functioning of several enzymes and is important for immune system function. It also functions as an antioxidant. Most animals are able to synthesize their own vitamin C. However, apes (including humans) and monkeys (but not all primates), most bats, some rodents, and other animals acquire it from dietary sources.

Vitamin C has a definitive role in treating scurvy, which is a disease caused by vitamin C deficiency. It is required only in a very small quantity to maintain good health. Around thirteen different vitamins including eight B vitamins are essential that are required to our body on daily bases. The recommended daily intake of ascorbic acid is 60 mg in aggregate [1, 2]. Ascorbic acid (AA) also known as vitamin C can be obtained from fruits or vegetables and multi-vitamin supplements. Ascorbic acid is important to the body for many reasons. It helps to regulate blood pressure, reduction of cholesterol level, scavenging of free radicals which are associated to many complications like acceleration in aging [3, 4, 5, 6].

Several analytical methods have been reported for the determination of AA using titrimetry [7, 8, 9]. Spectrometry [10], HPLC [11, 12, 13] and amperometry. The amount of Ascorbic acid in any unknown sample can be determined and quantified using iodometric titration. In redox titration method, iodine reacts with ascorbic acid to produce dehydroascorbic acid which is a colorless product. It reacts with starch to produce a dark blue end product.

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In presence of both ascorbic acid and starch, the iodine preferably reacts with the Vitamin C instead of the starch. Therefore, when iodine is added in the presence of both substances, the ascorbic acid reacts and the products are colorless. When the Ascorbic Acid has been completely used up, the iodine then reacts with the starch, and a dark blue product is formed. Hence, by the addition of iodine in drop wise manner, all of the Vitamin C utilizes first and the solution turns dark blue in the end.

The objective of this study is to determine the ascorbic acid content in grape, lemon, pineapple, watermelon and orange peels available within Ado Ekiti through redox titration.

2. Material and methods

2.1. Sample preparation

Some fresh ripe fruits (lemon, grape, pineapple, watermelon and orange) were collected from vendors in king's market in Ado-Ekiti, Ekiti State Nigeria. The fruits were washed in running water to remove adhesive contaminants. The peels were removed from the lemon, grape, pineapple, watermelon and orange fruits. They were dried in a shade/laboratory at room temperature for 2 weeks after which they were milled into fine powder using an electric blender. These were stored in an airtight container for further analysis.

2.2. Extraction process

50g of sample collected were weighed and poured in a clean beaker with well label for each fruit. 250 ml distilled water was added to each powdered materials of the fruit. Each well labelled beaker was allowed to sit for 20 minutes. After 20 minutes; the sample was filtered and the filtrate were kept at 4^0C in the refrigerator for further analysis.

2.3. Standardization of iodine solution

Iodine (I_2) is a halogen gas that evaporates quickly, hence, Iodine solutions need to be standardized all the time during experimental procedure. Ascorbic acid is also susceptible to oxidation by atmospheric oxygen over time. For this reason, the sample was prepared immediately before the titrations.

The iodine reagent was standardized by titrating it against 5ml of 1.00% ascorbic acid solution (to which three drops of 1% starch was added) until the appearance of the blue starch-iodine color.

The iodine solution was prepared by dissolving 5.00 g potassium iodide (KI) and 0.268 g potassium iodate (KIO_3) in 200 ml of distilled water, and then adding 30 ml of 3M sulfuric acid, before making up the volume to 500 ml with distilled water.

The concentration of ascorbic acid in the samples was determined as follows:

- Concentration in the pastes $(g/50g) = 25y/b$

Where b is titre (ml) from the titration of the standard ascorbic acid solution and y is titre (ml) from the titration of the sample solution.

5 g of potassium iodine, 0.28 g of potassium iodate was weighed and poured into conical flask. 200 ml of water was added to KI (Potassium Iodine) and KIO_3 (potassium iodate) after which 30 ml of H_2SO_4 was also added to dissolve the KI and KIO_3.

2.4. Preparation of starch solution

1 g of starch was weighed into a beaker and 100 ml of hot crystalline water was added to the starch to make starch solution which was used as an indicator. All reagents used are of analytical grades.

- Aliquot of the sample (10 ml) solution prepared above transferred into a 250 ml conical flask, 2 ml of 3M sulphuric acid, about 250 ml of distilled water and 1 ml of starch indicator solution.
- Samples were titrated with iodine solution. The endpoint of the titration was identified as the first distinct trace of a dark blue-black color due to the formation of starch-iodine complex.

- Titration were repeated with further aliquots of sample solution until concordant results (titres agreeing within 0.1 ml) were obtained.

2.5. Redox Titration

2.5.1. Vitamin C Standard Solution

- 10ml of the filtrate was measured using a measuring cylinder and titrated against iodine solution. Two drops of 1% starch solution was added to the 10ml filtrate.
- The titration was done gently by adding iodine solution and stirred until blue-black coloration was observed.
- Titration were repeated with further aliquots of sample solution until concordant results (titres agreeing within 0.1 mL) were obtained.

3. Calculations

$$\text{Mg of vitamin C (standard value)} = \frac{10\ ml}{250\ ml}$$

$$Mg\ of\ vitamin\ C\ oxidized\ by\ 10\ ml\ of\ iodine\ reagent = \frac{mg\ of\ vitamin\ C\ in\ flask}{Average\ (ml)\ of\ iodine\ reagent}$$

$$\text{Mg of vitamin C in fruit peels} = \frac{10\ ml\ \times mg\ of\ vitamin\ C}{1\ ml\ of\ friut\ peels\ solution}$$

$$\text{Solution of 10 ml 0f sample} = 50/250 = 0.2 g/Cm^3$$

$$10\ ml\ of\ iodine\ solution = \frac{10}{0.20\ g}$$

$$\frac{10}{0.20g} = \frac{5.40}{X\ Ml\ of\ vitamin\ C} = 0.108 g/Cm^3$$

$$\frac{10\ ml}{250} = \frac{0.108}{0.04}$$

$$= 2.70\ g/Cm^3\ of\ vitamin\ C\ in\ orange\ peel\ sample$$

The above calculations were done for all the peels to generate Table 1

4. Results and discussion

Ascorbic acid is an important vitamin for human health and also acts as co-factor for many enzymes. It is therefore needed for physiological functions in the body especially for the synthesis of important substances including collagen, and some neurotransmitters. Ascorbic acid accelerates hydroxylation reactions by increasing the activity of enzymes hydroxylase and oxygenase.

Ascorbic content: Table 1 contains fruit peels of Pineapple, Lemon, Grape, Watermelon and orange. It was observed that all the fruit peels were rich in Vitamin C. However, Pineapple peels (22.70 g/Cm^3), Lemon peels (10.93 g/Cm^3) and Orange peels (15.68 g/Cm^3) has preferable Ascorbic acid content compared to the pure ascorbic acid. In all the fruit peels analysis, the highest total yield of Vitamin C is the Pineapple peels (22.70 g/Cm^3) as shown in fig 2.

Table 1 Ascorbic Acid (AA) in gcm-3 of the fruit peels

	Fruit Peels	Value of Ascorbic acid (g/ cm3)	Ascorbic acid present / absent
1	Pure Ascorbic Acid	10.950	++
2	Pineapple	22.70	++
3	Lemon	10.93	++
4	Grape	15.68	++
5	Water melon	6.00	++
6	Orange	2.7	++

Key: ++ means present and ; – means absent

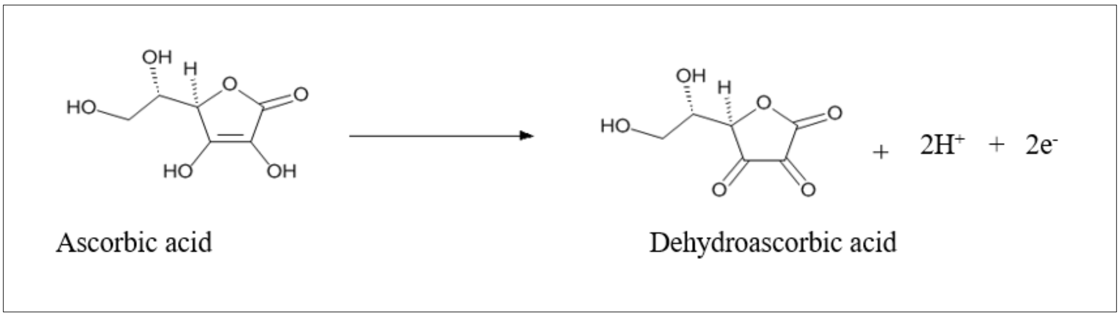

Figure 1 Chemical structure of ascorbic acid and dehydroascorbic acid as depicted through redox reaction

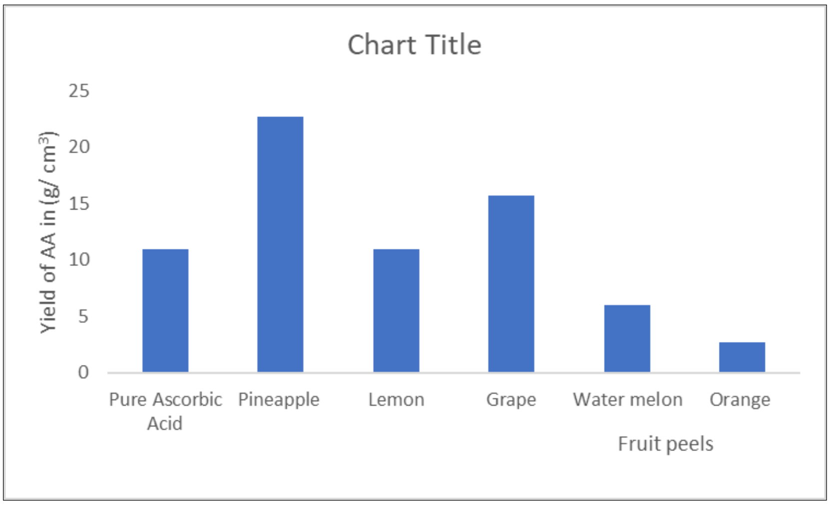

Figure 2 Total yield of the Ascorbic Acid (AA) in g/Cm^3 for each fruits

Ascorbic Acid analysis on fruit peels showed that various fruit peels consist of vitamin C which have certain amount of phenolic compound and high oxidation rate but in different proportion and fruit peels of Pineapple which has the highest amount of Ascorbic Acid/Vitamin C.

5. Conclusion

In this study, the obtained result revealed that the wasted parts particularly the peels of pineapple contain appreciable amount of ascorbic acid which can account for high amount of phenolic compound as well as high oxidation rate. Phenolic compounds from natural resources are recommendable as food additives in food processing more than the artificial antioxidants [14].

The results obtained proposes that the peels of fruits should not be discarded but used as food additives, boiled as tea, supplements and herbal mixtures to complement the recommended daily intake of vitamin C.

Compliance with ethical standards

Acknowledgments

This research work was carried out from personal commitment and expenses.

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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