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Effect of different storage conditions on the ascorbic acid content of plantain (*Musa paradisiaca*)

B. O. Agoreyo*, P. A. P. Aweh* and F. O. Agoreyo**

*Department of Biochemistry, Faculty of Science, University of Benin, Benin City, Nigeria
**Department of Anatomy, Faculty of Medicine, University of Benin, Benin City, Nigeria.

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ABSTRACT: Ascorbic acid levels of plantain (*Musa paradisiaca*) stored at ambient condition (28^{o}C) in the dark (30^{o}C) and refrigerated condition (14^{o}C) for a post harvest period of fourteen days were investigated using different assay techniques. There was a significant increase ($P<0.01$) in the level of ascorbic acid of plantain stored at ambient condition (28^{o}C) and in the dark (30^{o}C) while that stored at the refrigerated condition (14) showed a negligible increase as determined by these assay techniques.

The highest ascorbic acid level was found in the plantain stored in the dark (7.14mg per 100grammes fresh weight). These result showed that ascorbic acid content of plantain did not increase during storage compared to what is seen in other tropical fruits where the ascorbic acid content increase with storage. The result also suggest that the nature of ripening in plantain favours an increase synthesis of ascorbic acid an important oxidant, even when senescence has set in thereby making plantain a very good source of ascorbic acid at storage.

Key Words: Storage conditions; Ascorbic acid; *Musa paradisiaca*; Assay techniques.

Introduction

Plantain (*Musa paradisiaca*) is one of the best known fruits in the tropics. It is cultivated in almost all the tropics except the extremely arid tropics. Plantain like banana belongs to the genus *Musa* and the family Musaceae. After citrus, *Musa* is the most important fruit in the world trade (1).

Plantain is eating through the tropics. It can be eaten either ripe or unripe, and it is usually cooked, fried or roasted. Wine that is rich in vitamins is also produced from plantain (2). Plantain contains carbohydrates, fat and protein. The high carbohydrate and low fat content of plantain makes it of use in low fat diet. Plantain also contains appreciable amount of vitamins A, B and C (3).

Fruits such as plantain are the primary source of vitamin C (ascorbic acid) for humans, and their antioxidative action due to the presence of ascorbic acid is one of their important physiological functions. Ascorbic acid is an important naturally occurring antioxidant required to prevent scurvy and oxidative damages that are responsible for various such as cancer, cardiovascular diseases, diabetes, cataracts, premature aging , wrinkling of skin, stiffening of joints and much more in human (4). Periods of storage of some tropical fruits like paw-paw (*Carica papaya*), pineapple (*Ananas comosus*), avocado (*Persea*

americana) and African pear (*Dacryodes edulis*) have been found to decrease their ascorbic acid contents (2,3,5).

In this study, the ascorbic acid levels of plantain at different storage condition were investigated using various assay techniques, in order to determine the effect of storage on this important antioxidant.

Materials and Method

Plant Materials

Freshly harvested green mature plantain bunches were purchased from a market in Benin city, Nigeria. The plantain bunches were dehanded and the plantain samples were divided into three groups. The first group was stored at ambient condition (28^{o}C), while the second and the third groups where stored in the dark (30^{o}C) and refrigerated condition (14^{o}C) respectively. The plantain samples under these storage conditions were kept for a post harvest period of fourteen days and samples were collected daily from each group for analyses.

Extraction of Ascorbic Acid

Two methods were used to extract ascorbic acid from the plantain samples; the method of Coursey and Aidoo (6) and that of Bechett and Stenlake (7).

Method of Coursey and Aidoo (6)

Five grammes of plantain pulp was homogenized with 120ml of 5% glacial acetic acid. The homogenate was filtered through a double layer of cheesecloth and the filtrate was used as the ascorbic acid extract.

Method of Bechett and Stenlake (7)

Ten grammes of plantain pulp were homogenized with 50ml of distilled water and 2.5ml of 1M sulphuric acid (H_2SO_4). The homogenate was filtered through a double layer of cheese cloth and the filtrate was used as the ascorbic acid extract.

Assay of Ascorbic Acid

Two assay techniques were also used to determine the ascorbic acid content of the ascorbic acid extract. The ascorbic acid techniques are 2,6-dichlorophenol indophenol method (6) and iodometric method (7).

2,6-Dichlorophenol indophenol Method

The ascorbic acid extract obtained from the Method of Coursey and Aidoo (6) was titrated against 5 ml of 2,6-dichlorophenol indophenol (coloured dye) until the end point was observed. The end point was the colour of the extract. The dye was standardized by titrating 5 ml of it with 0.02 mg/ml freshly prepared ascorbic acid. The standard ascorbic acid was titrated against the dye until the dye became colourless, which was the end point. The working concentration of the dye was 0.08 g/litre.

Iodometric Method

A 1.5ml portion of 1% starch solution was added to the ascorbic acid extract obtained from the method of Bechette stenlake as an indicator and 0.05M iodine solution was titrated against it until a persistent violet blue colour was observe which was the end point. The 0.05M iodine solution was standardise with 0.1M sodium Thiosulphate solution which had been standardized with potassium iodate as a primary standard. Standard ascorbic acid prepared by dissolving 0.2g of ascorbic in a mixture of 50ml of distilled water and 2.5ml of 1M sulphuric acid with 1.5ml of 1% starch (indicator) was also used to standardize the 0.05M iodine solution.

Results

The two assay techniques used to determine the ascorbic acid content in the plantain samples showed that the level of ascorbic acid of plantain stored at ambient condition (28^oC) and in the dark (30^oC) increased significantly while those stored at refrigerated condition (14^oC) showed a negligible increase during the period of storage (Figs 1 & 2).

The plantain stored at refrigerated condition showed little or no ripening, they remained green through out the period of storage and the ascorbic acid level showed a negligible increase by both assay techniques. (Table 1) Ripening was first observed in plantain samples stored in the dark (30^oC) and the highest level of ascorbic acid was recorded in these plantain samples (Fig. 1). The plantain samples stored at ambient temperature (28^oC) also ripen and showed increase in ascorbic acid level during storage (Figs 1 & 2).

The plantain samples stored at ambient condition (28^oC) and in the dark (30^oC) were fully ripened by the 8^{th} day of storage and were overripe and senescent by the 14^{th} day of storage. The result showed that the level of ascorbic acid in the plantain samples increased with storage especially at ambient condition (28^oC) and in the dark (30^oC) where ripening occurred.

Discussion

Ascorbic acid is synthesized from glucose by the uronic acid pathway in plants which include fruits like plantain. Man and guinea pigs cannot synthesize ascorbic acid from glucose (11), therefore man depends on fruits as primary source of ascorbic acid (4).

During the post harvest storage of plantain at ambient condition (28^oC) and in the dark (30^oC) in the study, ripening occurred. In plantain, starch is converted to reducing sugar of which glucose is one of them, during ripening (3,8,9), since ripening occurred in the plantain samples stored at ambient condition and in the dark, the starch contained in them, was converted to glucose which was used to synthesize ascorbic acid during storage. Marriot et al (9) also observed that the hydrolysis of starch to sugar in plantain was continuous even when the fruits were senescent but in banana, which is of the same genus as plantain (1), the hydrolysis of starch to sugar was complete when the fruit fully ripened and did not take place in senescent fruits. Marriot et al (9) also observed that there was a continuous increase in the concentration of glucose during ripening with the senescent fruits having the highest value due to the continuous breakdown of starch (9). The significant increase in ascorbic acid level observed in plantain samples stored at ambient condition (28^oC) and in the dark (30^oC) where ripening occurred (Figures 1 & 2) was due the increase in the synthesis of ascorbic acid from increased glucose level that was produced during ripening. The nature of ripening in plantain, where there is a continuous hydrolysis of starch to sugar and an increase production of glucose even in senescent fruits favours an increase synthesis of ascorbic acid, during storage even when senescence has set in.

Although periods of storage have been found to decrease the ascorbic acid contents of some tropical fruits stored at ambient condition (2,5), due to the degradation of the ascorbic acid by light, a phenomenon that is known as photodegradation , the effect of this phenomenon even though it occurs in plantain was not observed especially in plantain stored at ambient condition (28^oC) that was exposed to light, because the increase synthesis of ascorbic acid from glucose during ripening exceeds its degradation. Moreover these tropical fruits do not have the same nature of ripening as plantain where sugar production takes place in senescent fruits.

The plantain samples stored at refrigerated condition (14^oC) which did not ripen, did not show any significant increase in ascorbic acid because there was no significant increase in glucose that could bring about a significant increase in the syntheses of ascorbic acid. During the storage of yam , starch is also converted to reducing sugars especially glucose which is used to synthesize ascorbic acid, as in plantain.

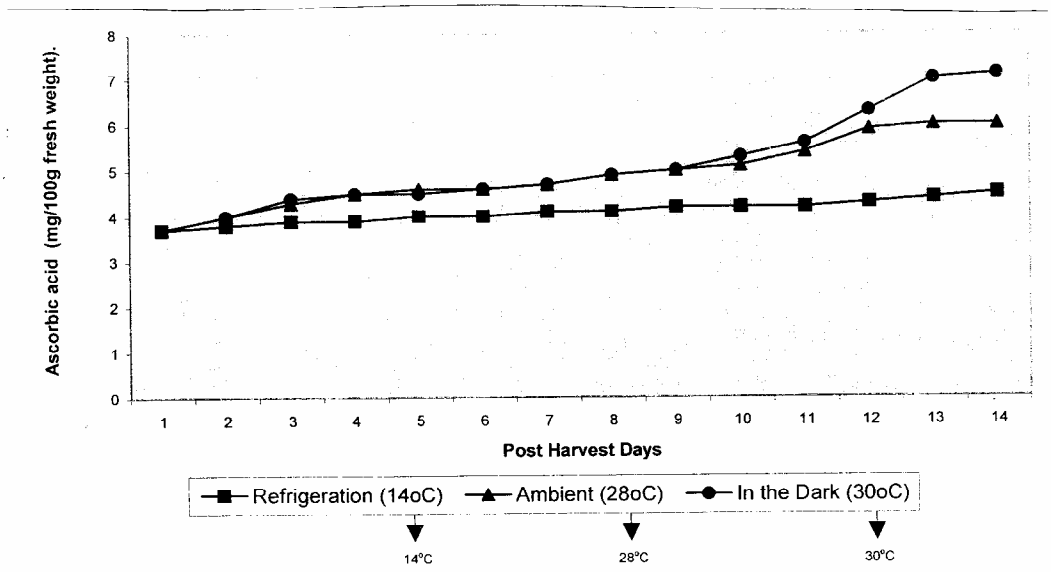

Figure 1: Ascorbic acid content of plantain stored under different conditions using the 2,6-dichlorophenol indophenol method.

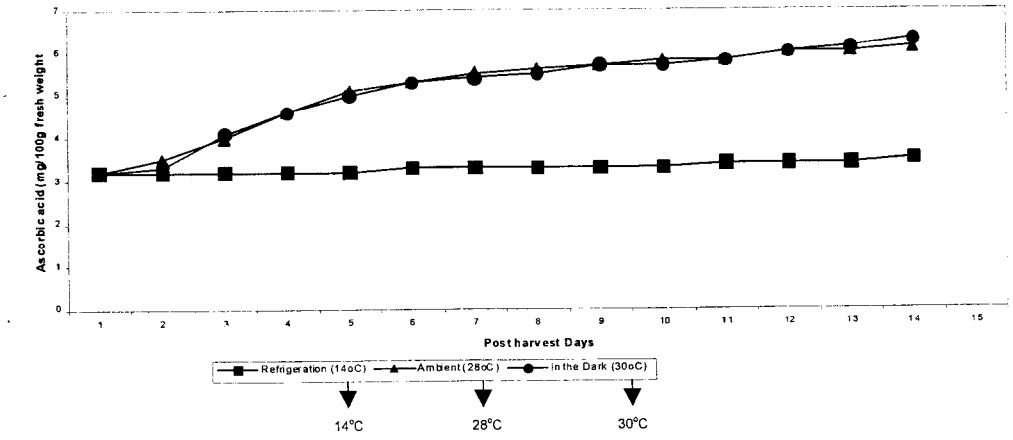

Figure 2: Ascorbic acid content of plantain stored under different conditions using the iodometric method

Table 1: Ascorbic acid content of plantain stored at three different storage condition, using 2, 6 dichlorophenol indophenol and iodometric methods (mg/100g fresh weight).

Days	Refrigerated Condition (14°C)				Ambient Condition (28°C)				In the dark (30°C)			
	a	(%)*	b	(%)*	a	(%)*	b	(%)*	a	(%)*	b	(%)*
1	3.69 ± 0.08	(0.00)	3.15 ± 0.00	(0.00)	3.69 ± 0.00	(0.00)	3.15 ± 0.00	(0.00)	3.69 ± 0.00	(0.00)	3.15 ± 0.00	(0.00)
2	3.82 ± 0.05	(3.52)	3.15 ± 0.00	(0.00)	3.96 ± 0.02	(7.32)	3.50 ± 0.14	(11.11)	4.00 ± 0.07	(8.40)	3.32 ± 0.01	(5.40)
3	3.87 ± 0.03	(4.82)	3.19 ± 0.00	(1.27)	4.30 ± 0.02	(16.53)	4.02 ± 0.14	(27.62)	4.38 ± 0.01	(18.70)	4.11 ± 0.07	(30.48)
4	3.89 ± 0.02	(5.42)	3.22 ± 0.01	(2.22)	4.54 ± 0.01	(23.03)	4.64 ± 0.14	(47.30)	4.50 ± 0.08	(21.95)	4.55 ± 0.11	(44.44)
5	4.00 ± 0.00	(8.40)	3.25 ± 0.01	(3.17)	4.60 ± 0.04	(24.66)	5.07 ± 0.07	(60.95)	4.53 ± 0.02	(22.76)	4.99 ± 0.07	(58.41)
6	4.00 ± 0.00	(8.40)	3.24 ± 0.01	(2.86)	4.64 ± 0.01	(25.75)	5.27 ± 0.05	(67.30)	4.60 ± 0.02	(24.66)	5.25 ± 0.07	(66.67)
7	4.05 ± 0.02	(9.76)	3.25 ± 0.01	(3.17)	4.74 ± 0.01	(28.46)	5.51 ± 0.07	(74.92)	4.74 ± 0.02	(28.46)	5.42 ± 0.07	(72.06)
8	4.08 ± 0.01	(10.57)	3.27 ± 0.01	(3.81)	4.94 ± 0.01	(33.88)	5.62 ± 0.05	(78.41)	4.89 ± 0.01	(32.52)	5.51 ± 0.00	(74.92)
9	4.15 ± 0.01	(12.47)	3.31 ± 0.01	(5.08)	4.99 ± 0.02	(35.28)	5.69 ± 0.07	(80.64)	5.04 ± 0.02	(36.59)	5.65 ± 0.03	(79.37)
10	4.20 ± 0.02	(13.82)	3.33 ± 0.01	(5.71)	5.14 ± 0.00	(39.30)	5.80 ± 0.08	(84.13)	5.28 ±0.05	(43.09)	5.69 ± 0.07	(80.64)
11	4.21 ± 0.01	(14.09)	3.36 ± 0.01	(6.67)	5.41 ± 0.04	(46.61)	5.80 ± 0.08	(84.13)	5.58 ± 0.04	(51.22)	5.83 ± 0.04	(85.08)
12	4.33 ± 0.03	(17.34)	3.37 ± 0.01	(6.98)	5.87 ± 0.07	(59.08)	6.04 ± 0.07	(91.75)	6.26 ± 0.05	(69.65)	5.95 ± 0.07	(88.89)
13	4.44 ± 0.03	(20.33)	3.39 ± 0.01	(7.62)	6.00 ± 0.04	(62.60)	6.04 ± 0.07	(91.75)	7.00 ± 0.02	(89.70)	6.12 ± 0.00	(94.29)
14	4.50 ± 0.00	(21.95)	3.50 ± 0.01	(11.11)	6.00 ± 0.00	(62.60)	6.14 ± 0.02	(94.92)	7.14 ± 0.02	(93.50)	6.30 ± 0.00	(100)

a = 2, 6 – dichlorophenol indophenol method
b = Iodometric method
* Percentage increase
Results are expressed as mean ± S D for three determinations

Osagie has also observed that there was no significant decrease in the ascorbic acid level of yam during storage in as much as there is no mechanical damage which could accelerate deterioration of yam and degradation of ascorbic acid (10). Plantain, from this study was found to increase in ascorbic acid with storage even in senescence. Post harvest storage does not decrease the ascorbic acid content of plantain. The consumption of ripe plantain is thus a better source of Ascorbic acid than the unripe plantain.

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