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DETERMINATION OF VITAMIN C AND MINERAL CONTENT OF TWO LOCAL SPECIES OF *Carica papaya* (*SAMBA* AND *HORTUS GOLD PAPAYA*) AT VARIOUS STAGES OF RIPENING

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ABSTRACT

Papaya (*Carica papaya Linn*) is a popular fruit grown in the tropical and subtropical parts of the world, also known as "pawpaw". The fruit is consumed when ripe and also processed. The many benefits of papaya are owed due to the high content of Vitamin A, B and C, and minerals. This study aimed at determining the concentration of vitamin C in two species of the fruits as a function of the ripening periods, using the redox titration method indicated that the concentration of vitamin C decreased from 98 mg/kg to 70 mg/kg in *Samba papaya* and from 96 mg/kg to 68 mg/kg in the *Hortus gold papaya* with ripening period. *Samba papaya* is recommended for vitamin C enhancement at the early ripening stage. Calcium, magnesium and potassium concentrations determined using atomic absorption spectrophotometry decreased in concentration with storage day. Domestic and industry supply of vitamin C and essential minerals is key to health need to be obtained from fruits at the optimum stage.

Keywords: Vitamin C, *Papaya*, Ripening, Maturity, Optimum, Minerals

INTRODUCTION

In today's world, people often consume food without considering its nutritional value or its impact on their health (Spiteri Cornish and Moraes, 2015). It is crucial to understand when to consume the vitamins and minerals found in fruits to make informed dietary choices.

Papaya, known as *Carica papaya L*., is a major fruit crop grown in tropical and sub-tropical regions (Koul *et al*., 2022). In 2004, the global production of papaya reached over 6.8 million tonnes (Mt), cultivated on approximately 389,990 hectares (Ha), with 47% of the production taking place in Central and South America, 30% in Asia, and 20% in Africa (Saeed *et al*., 2014). Brazil stands out as a key player in the papaya industry, experiencing rapid growth in cultivation and production over the past decade. This expansion has been remarkable, with a 151% increase in cultivated area (from 16,012 ha in 1990 to 40,202 ha in 2000) and a 164% increase in production (from 642,581 to 1,693,779 fruits) during the same period, as reported by Saeed et al. (2014).

While papaya is predominantly grown and consumed in developing countries, it is gaining recognition as an important fruit globally, both as a fresh fruit and in processed products. A significant body of research and literature has been dedicated to papaya fruits and seeds. The edible part of the *C. papaya* fruit, commonly known as pawpaw, contains essential macro- and micro-minerals, such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn) (Co-operation and Development, 2010). Additionally, the fruit is a rich source of carotenoids, vitamin C, thiamine, riboflavin, niacin, vitamin B6, and vitamin K (Bellows *et al*., 2012; Rickman *et al*., 2007). Notably, papaya seeds have shown promise in treating sickle cell diseases (Dotto and Abihudi, 2021), renal disorders related to poisoning (Francis et al., 2023), and as an antihelminthic (Mohammed et al., 2014).

Papaya plants have been traditionally used for medicinal purposes in various countries and serve as sources of potent drugs. The antimicrobial and antifungal properties of *Carica papaya* plant extracts from different leaves have been investigated using established methods described in the literature. Furthermore, phytochemical screening of leaf extracts, including tests for alkaloids, carbohydrates, saponins, proteins, amino acids, tannins, flavonoids, glycosides, and terpenoids, has been conducted following standard procedures detailed in existing literature.

Studies showed that vitamin C in pawpaw, grape, lemon, orange, and cashew rank in the order unripe < ripe < half-ripe. Vitamin C in the selected fruits is being in the order orange > pawpaw > cashew > grape > lemon (Okei *et al*. 2009). This signifies that fruit variety, specie, weather, maturity and ripening stages are key in maximizing the benefits of fruits to man (Rahman *et al*., 2007).

However, despite the several nutritional, mineral and medicinal benefits of C. papaya, the optimization of these inherent constituents for man's use has been hampered by the consumption of the fruits at different stages of ripening. Therefore, the focus of this study is to determine which of the two local papaya species, namely *Samba* and *Hortus gold papaya*, possesses a higher concentration of Vitamin C and other essential minerals K, Ca and Mg) and the best day of ripening. This is achievable.

MATERIALS AND METHODS

Sample collection

In June 2021, two distinct local papaya species, namely 'Samba' and 'Hortus gold,' were procured simultaneously from Gwagwalada, Abuja. These specimens were subsequently transported to the Department of Biological Sciences at Ahmadu Bello University, Zaria, for identification.

Sample preparation for the determination of vitamin C

A 100 g of papaya fruit of each specie was first diced into small pieces and then processed using an agate mortar and pestle. During this process, 100 cm^3 portions of distilled water were added gradually while grinding the sample. After each addition of water, the liquid extracts were carefully separated by decanting into a 100 cm^3 volumetric flask for each experimental group.

Subsequently, the remaining pulp was strained using cheesecloth. To ensure all remaining extract was collected, the pulp was rinsed with 10 cm^3 portions of distilled water, and the resulting filtrate and washings were combined in a volumetric flask. Finally, the extracted solution was topped up to a total volume of 100 cm^3 using distilled water (Ikewuchi and Ikewuchi, 2011).

Sample Preparation for the Determination of Minerals (Calcium, Magnesium and Potassium)

A 1 g portion of both specie of papaya was heated separately for 2 hours with 20 cm^3 aqua regia (15 cm^3 concentrated HCl pa and 5 cm^3 concentrated HNO_3 pa). After cooling, the digestion residue was filtered through a highly sensitive filter and rinsed with acid into a 100 cm^3 volumetric flask. Rinsing of the digestion glass and of the filter as well as filing up of the digested solution to 100 cm^3 in a volumetric flask took place with hot distilled water.

Experimental procedure for determination of vitamin C

A 20 cm^3 aliquot of the prepared sample solution of each of the pawpaw specie was pipetted into a 250 cm^3 conical flask and about 150 cm^3 of distilled water and 1cm^3 of starch indicator solution was added.

The sample was titrated with 0.005 mol L^{-1} iodine solution. The endpoint of the titration was identified as the first permanent trace of a dark blue-black colour due to the starch-iodine complex. The titration was repeated with further aliquots of sample solution until concordant results were obtained (titres agreeing within 0.1 cm^3).

Ascorbic acid + I_2 → 2I + Dehydroascorbic acid

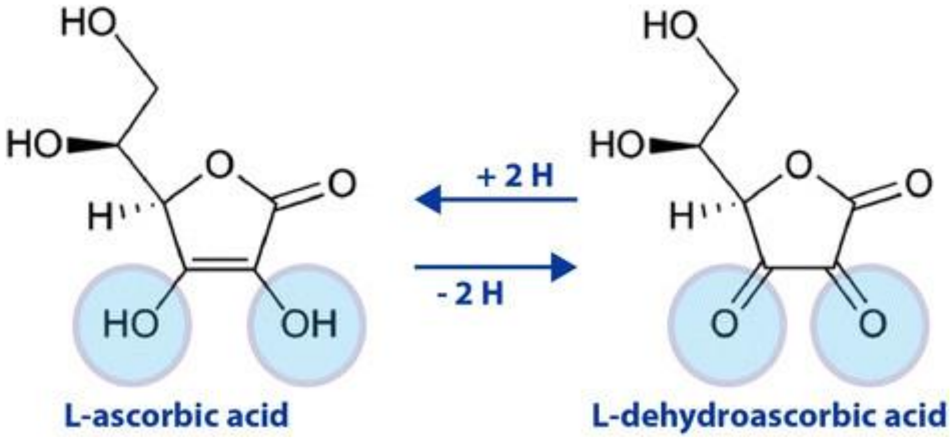

Figure 1: oxidation of L-ascorbic acid (Yurena *et al.,* 2005)

Experimental procedure for determining minerals using atomic absorption spectrometers (AAS)

Preparation of standards: The method of standard addition was used to overcome the problem of matrix interferences. Therefore, a series of standards was prepared containing an aliquot of the unknown plus increasing amounts of the known mineral depending on the particular mineral tested for (calcium, potassium and magnesium).

A known mineral standard was prepared in 0.1 M nitric acid with the same (or very close to the same) concentration as the estimated amount of known mineral in the unknown. This was used to prepare standards for the standard addition calibration. Six 25 cm^3 volumetric flasks were obtained. To each flask, 10 cm^3 of the unknown was added. Then the following was added to each flask:

i. Flask 1: Dilute to the mark with 0.1 M HNO_3.
ii. Flask 2: 1 cm^3 of known mineral standard from step 1 and diluted to the mark with 0.1 M HNO_3.
iii. Flask 3: 2 cm^3 of known mineral standard from step 1 and diluted to the mark with 0.1 M HNO_3.
iv. Flask 4: 3 cm^3 of known mineral standard from step 1 and diluted to the mark with 0.1 M HNO_3.
v. Flask 5: 4 cm^3 of known mineral standard from step 1 and diluted to the mark with 0.1 M HNO_3.
vi. Flask 6: 5 cm^3 of known mineral standard from step 1 and diluted to the mark with 0.1 M HNO_3.

The instructions provided were followed to measure the atomic absorbance signal for each solution.

RESULTS AND DISCUSSION

From the result presented in Figure 2, the concentration of vitamin C in both the Samba and Hortus gold papaya decreased progressively with ripening at day 0 to 7. Specifically, on day 0, the vitamin C concentration in Samba papaya was measured as 98 mg/kg, while on day 7, it had decreased to 70 mg/kg. Similarly, in Hortus gold papaya, the initial vitamin C concentration on day 0 was 96 mg/kg, which decreased to 68 mg/kg on day 7. This decline in vitamin C content can be attributed to the increase in acid content in the fruit leading up to harvest, with a subsequent decrease in acidity during storage.

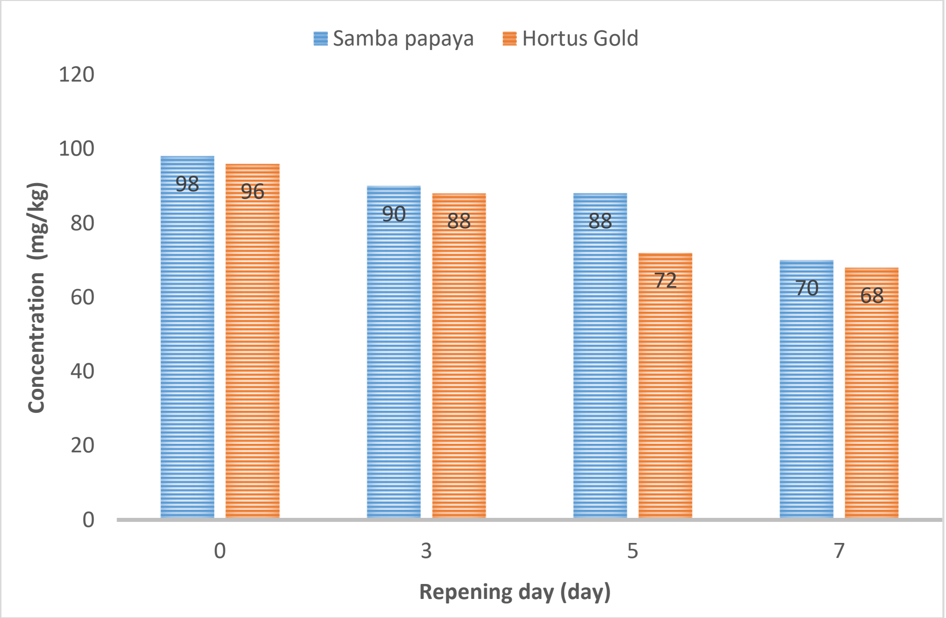

Figure 2: Effect of ripening day on the vitamin c content of pawpaw species

However, this result is contrary to the work of Okei *et al*. (2009) in which the vitamin C in pawpaw increased with the ripening days; and was highest when half-ripe.

The decrease in vitamin C in this study can be attributed to the decrease in total acid levels during storage. Which is a result of the utilization of organic acids in the respiration process. It is worth notice that the World Health Organization recommends a daily intake of 90 mg/kg of vitamin C, which corresponds to the concentration of vitamin C observed in Samba papaya on day 3. Further, it is observed that Samba papaya consistently maintains a higher concentration of vitamin C across all ripening stages, compared to the Hortus gold papaya specie. This implies that for enhanced intake of vitamin C from papaya, the Samba specie is more enriched and is recommended, at the early stage of the repining process.

Table 1: Calcium Content of the Two Species of *Papaya*

S/N	Varieties	Ripening days	Concentration (mg/kg)
1.	Samba papaya	0	310
2.		3	250
3.		5	250
4.		7	210
5.	Hortus gold papaya	0	285
6.		3	220
7.		5	186
8.		7	115

Table 2: Magnesium Content of the Two Species of *Papaya*

S/N	Varieties	Maturity stages	Concentration (mg/kg)
1.	Samba papaya	0	220
2.		3	190
3.		5	180
4.		7	170
5.	Hortus gold papaya	0	210
6.		3	180
7.		5	140
8.		7	130

Table 3: Potassium Content of the Two Species of *Papaya*

S/N	Varieties	Ripening days	Concentration (mg/kg)
1.	Samba papaya	0	2750
2.		3	2300
3.		5	1980
4.		7	1880
5.	Hortus gold papaya	0	2400
6.		3	2100
7.		5	1900

8.	7	1650

The study indicated that calcium concentration in the fruit also decreased with the ripening stage (Table 1). On day 0, *Samba papaya* had a calcium concentration of 310 mg/kg, while *Hortus gold papaya* had 285 mg/kg. By day 7, these values declined to 210 mg/kg for the *Samba papaya* specie and 115 mg/kg for *Hortus gold papaya*. The recommended daily intake of calcium by the World Health Organization is 1300 mg/kg, the results show that both papaya species at high intake can supply most Ca daily intake.

From Figure 2, the concentration of magnesium also exhibits a significant decrease from day 0 to day 7 for both *Samba* and *Hortus gold papaya*. On day 0, *Samba papaya* had a magnesium concentration of 220 mg/kg, while *Hortus gold papaya* had 210 mg/kg. However, by day 7, these values declined to 170 mg/kg for the *Samba papaya* and 130 mg/kg for *Hortus gold papaya*. The World Health Organization recommends a daily intake of 320 mg/kg of magnesium; indicating that at ripening the two species can serve as a good source of Mg.

Potassium is another essential mineral, crucial for regulating various bodily functions. The World Health Organization recommends a daily intake of 3510 mg/kg. As presented in Table 3, *Samba papaya* had a potassium concentration of 2750 mg/kg on day 0, which decreased to 1880 mg/kg on day 7. Similarly, *Hortus gold papaya* showed a decrease in potassium concentration from 2400 mg/kg on day 0 to 1650 mg/kg on day 7.

The study therefore reveals that both Samba and Hortus gold papaya varieties of pawpaw had a decline in vitamin C, calcium, magnesium, and potassium concentrations as each ripens. However, with respect to the recommended daily intake levels, vitamin C, Ca, Mg and K are well enriched in the two species of pawpaw even as the ripening progressed from maturity to day 7. Therefore, the fruit can serve as a source of these nutritional and mineral elements within any of the days of ripening and can be explored as a domestic and industrial food supply.

CONCLUSION

Based on the study, the levels of vitamin C and various minerals (such as calcium, magnesium, and potassium) in both local papaya species (Samba and Hortus gold papaya) consistently declined during the repining stage. The findings indicate that Samba papaya possesses superior nutritional content compared to Hortus gold papaya. The optimal time for consumption of Samba papaya is its unripe stage on day zero (0), as opposed to its less nutritious overripe stage on day seven (7). Therefore, it can be concluded that while ripe papaya (day 7) is enjoyable and suitable for consumption, unripe papaya (day 0) is recommended for its superior nutritional value.

RECOMMENDATION

*Carica papaya s*hould be given global attention based on its rich nutritional and medicinal value. Research should be carried on to determine the effective ways of preservation, in order to retain its nutritional value for at least 2 to 3 years.

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