

## Effects of Storage Period on Some Nutritional Properties of Orange and Tomato

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### Abstract

*Fruit and vegetables are important sources of digestible carbohydrates, minerals and vitamins, particularly vitamins A and C. The samples of orange and tomato fruits used for this study were stored in the pot-in-pot evaporative cooler for 21 days during which tests carried out to quantify some nutritional parameters of moisture, ash, protein, lipid, vitamin C, carbohydrate and total sugar contents were assessed periodically. The study revealed that there were continuous decreases in the quality parameters, such as vitamin C content from 3.30 to 0.00% for tomato and 7.52 to 0.49% for orange, lipid content from 0.22 to 0.00% for tomato and 0.29 to 0.07% for orange, carbohydrate content from 23.47 to 4.19% for tomato and 12.23 to 9.53% for orange, protein content for tomato ranged between 0.05 and 0.01% for tomato and 0.18 to 0.04% and total sugar content for tomato ranged from 0.43 to 0.14% and for 0.65 to 0.25%, while the value of moisture content increased from 74.77% and 85.32% for tomato and orange, respectively, with increase in storage period.*

**Keywords:** Nutritional parameters, vitamin C, moisture content, sugar content.

### Introduction

Fruits and vegetables form an essential part of a balanced diet. They are important part of the world agricultural food production, even though their production volumes are small when compared with grains. Fruits and vegetables are important sources of digestible carbohydrates, minerals and vitamins, particularly vitamins A and C. In addition, they provide roughage (indigestible carbohydrates) which is needed for normal healthy digestion (Salunkhe and Kadam 1995).

Vegetables are good sources of carbohydrates, vitamins and minerals and are considered a staple source of stew and soup ingredient in Nigeria. The quality good shelf-life of vegetables is related to some biochemical processes that take place after harvest. Physiological actions such as respiration involves heat emission of heat resulting in temperature increase, and this accelerates metabolic processes and decay

phenomena (Sánchez-Mata *et al.* 2003). Green vegetables have high respiration rate which limits their shelf-life after harvest to 1-4 weeks maximum. This is partly attributed to the high metabolic activity of the leaves and in some cases the seeds inside some of the fruits (Wills *et al.* 1999).

However, at later stages of ripening, the degradation process increases with the hydrolysis of starch and the consumption of soluble sugars on respiration (Muñoz-Delgado 1985). In order to extend the shelf-life of vegetables, several authors have recommended the storage of these products at 4-10°C (Wills *et al.* 1999). Modified or controlled atmosphere storage is also a useful technique for extending shelf-life of vegetables, especially for those that deteriorate quickly (Sánchez-Mata *et al.* 2003).

In most vegetable products, when the external oxygen presence is low, there is decrease of respiration activity, which is attributed to reduction of oxidize activities, such as polyphenol-oxidase, ascorbate-oxidase and glycolic-oxidase (Sánchez-Mata *et al.*

2003). Low oxygen levels can also induce the suppression of genes that codify maturation associated enzymes, such as cellulose, polygalacturonase, acid invertase, sucrose-phosphate-synthase and amine cyclopropane-1-carboxylate-oxidase (Kanellis *et al.* 1991). Kadder (1997) reported that in general, oxygen level should be under 5% to obtain a decrease of respiration activity.

Controlled storage conditions are essential for the preservation of vegetables. Modern storage methods for horticultural produce are based on refrigeration and

environment control. These include mechanical refrigerated storage, controlled atmosphere and low pressure storage system. These methods are usually too expensive for the local people which live in remote parts of Nigeria. There are required simple low-cost cooling systems for the storage of perishable produce. The Nigerian Stored Products Research Institute (NSPRI) developed some passive evaporative cooling system (NSPRI 1990). One such system is the “pot-in-pot” method which is shown in Fig. 1. It consists of a burnt clay plot of about 65cm height and a wall thickness of about 8mm.



Fig. 1. Photograph of a pot-in-pot storage method.

The small pot was placed inside another slightly bigger pot leaving a space of about 7cm all around. The space between the pots was filled with river bed sand and the sand is kept moist by watering frequently. The clay pot was provided with a suitable lid. The evaporative cooler works on the principle of cooling resulting from the evaporation of water from the surface of the structures. The cooling achieved from this device also results in the high relative humidity of the air in the chamber from which the evaporation takes place relative to the ambient air.

One of the major problems is what happens to the nutritional quality parameters of the fresh produce during the period of storage. Quantifying these can actually help in determining how long the produce can be kept without losing substantial part of the nutrients.

The objective of this study is to assess how the period of storage actually affects the properties of the fresh tomato and orange fruits and to obtain the optimum period that they can be stored without losing their essential properties in this storage system.

## Materials and Methods

The samples of oranges and tomatoes used for this study were obtained from some farms located along Bida-Minna Road, very early in the morning, which was done to avoid the rough handling at the market places. The fruits were then stored in a pot-in-pot evaporative cooler. Some samples were immediately assessed for the required nutritional qualities. The design was such that samples of the fruits were taken every 7 days and assessed for their nutritional qualities until

the entire fruits got deteriorated. In addition to the nutritional quality parameters being assessed, the temperature and the relative humidity of the storage system were monitored throughout the storage period. In this study, the properties of orange fruits stored in the pot-in-pot storage system (Evaporative Cooler, EVC) were determined.

Moisture content, total ash content and lipid content were determined using the method outlined by the AOAC (1990) while protein content was determined using the micro-Kjedahl method described by Brenndorfer (1995).

#### **Determination of Ascorbic Acid Vitamin C Using DCPIP Dye**

5ml of dilute fruit juice was pipetted into a boiling tube and 1ml of glacial acetic acid was added and titrated with the dye solution to a faint permanent pink colour. The titre ( $T$ ) was recorded. The titration was repeated with 5ml of water for the blank ( $B_1$ ) and 5ml of ascorbic acid standard solution ( $st$ ) and vitamin C content of the test sample was calculated using the relationship:

$$\text{Vitamin C Test (mg/100ml)} = [(T - B_1)/(st - B_1)] \times \text{Dilution factor.}$$

#### **Determination of Sugar Content by DNS Reagent**

5ml distilled water was homogenized with a suitable quantity of the fruit juice for 3 minutes. An extract of 100ml was made in the volumetric flask and centrifuged at approximately 1,000rpm for 15 min. For sugar content analysis, 15ml of 1M hydrochloric acid was added and 10ml of distilled water. This was boiled gently for 3 minutes and cooled in a beaker of tap water and then diluted to 20ml with water. It was mixed well and the absorbance of each tube was measured in a spectronic 20, zeroing with tube 1. A calibration curve was prepared from the results obtained for tubes 2, 3, and 4 by plotting absorbance vertically against moles of glucose plus fructose in each tube as abscissa. The sugar content was obtained from the standard calibration curve (Anon. 2002).

## **Results and Discussion**

The results of the assessed nutritional qualities of tomato are shown in Table 1 while that of orange are shown in Table 2. The average temperature of the inner chamber was 20°C while the relative humidity was 78%. The average prevailing ambient temperature during the period was 35°C while the RH was 70%.

### **Moisture Content**

The initial moisture content of tomato used for this study was 74.77% while that of orange was 85.32% which were within the range stated by ISO standard (1987) of 87.1%. It was observed that moisture content of the stored products in this storage method increased from this initial value to 95.34% after the 14<sup>th</sup> day of storage for tomato while that of orange was 89.81%. This increase in moisture content correlates well with the variation of the relative humidity. The frequency of wetting of the river sand leads to the increase in relative humidity within the inner chamber. Physiological activities of the produce also lead to this increase in moisture content.

### **Ash Content**

The results of the ash content assessed showed that there was gradual decrease in the quality parameters as the storage period increases. The average values of the ash content on the 1<sup>st</sup> day of storage were 1.49% and 1.98% for fresh tomato and orange, respectively. After 14 days of storage, the values were 0.46% and 1.54% for tomato and orange, respectively, showing that 69.13 and 22.22% of the values of ash content were lost from tomato and orange, respectively, within two weeks. These values are by no means small when one is concerned with nutritional values.

### **Protein Content**

The result of the protein content of fresh tomato and orange was assessed to be 0.05 and 0.18%, respectively, on the 1<sup>st</sup> day of storage.

Table 1. Mean values of the nutritional parameters of tomato fruit.

Period of storage (days)	Parameter						
	Moisture Content (%)	Ash Content (%)	Protein Content (%)	Lipid Content (%)	Vitamin C Content (mg/ml <sup>-1</sup> )	Carbohydrate Content (%)	Total Sugar Content (%)
1 <sup>st</sup>	74.77	1.49	0.05	0.22	3.30	23.47	0.43
7 <sup>th</sup>	77.17	0.92	0.03	0.20	0.49	21.68	0.34
14 <sup>th</sup>	95.34	0.46	0.01	0.00	0.00	4.19	0.14
21 <sup>st</sup>	-	-	-	-	-	-	-

Table 2. Mean values of the nutritional parameters of orange fruit.

Period of storage (days)	Parameter						
	Moisture Content (%)	Ash Content (%)	Protein Content (%)	Lipid Content (%)	Vitamin C Content (mg/ml <sup>-1</sup> )	Carbohydrate Content (%)	Total Sugar Content (%)
1 <sup>st</sup>	85.32	1.98	0.18	0.29	7.52	12.23	0.65
7 <sup>th</sup>	86.83	1.54	0.12	0.19	4.88	11.32	0.55
14 <sup>th</sup>	89.50	1.10	0.09	0.12	1.46	9.19	0.37
21 <sup>st</sup>	89.81	0.55	0.04	0.07	0.49	9.53	0.25

On the 14<sup>th</sup> day, when the test was repeated for the stored fruits, results of 0.01% and 0.09% were obtained for tomato and orange, respectively, showing that 20% and 50% of the values of protein content were lost in tomato and orange, respectively. This shows a similar trend as observed for ash content. As the period of storage increases, the protein content of the samples decreases. The values observed here are far less than those observed by Cheema and Karmarkar (1939) which may be due to the difference in variety and environmental conditions.

### Lipid Content

The result of the lipid content of fresh tomato and orange was assessed to drop from 0.22% to 0.00% and 0.29% to 0.12%, respectively, between the 1<sup>st</sup> and 14<sup>th</sup> day of storage. The test also shows a continuous decrease in the lipid content as the period of storage increases.

### Vitamin C Content

Vitamin C contents of tomato and orange fruits were assessed on the first day (before storage) as 3.30mg/ml<sup>-1</sup> and 7.52mg/ml<sup>-1</sup>, respectively. After 14 days of storage the vitamin 'C' content of tomato and orange fruits were assessed to be 0.00mg/ml<sup>-1</sup> and

1.46mg/ml<sup>-1</sup>, respectively. This result shows that there were continuous decreases in Vitamin 'C' content as the period of storage increases, showing that the percentage reductions of the protein content are 0.00% and 19.41% for tomato and orange, respectively.

### Carbohydrate Content

The carbohydrate content was assessed for tomato and orange to be 23.49% and 12.23%, respectively, on the first day of storage and on the 7<sup>th</sup> day of storage the carbohydrate content of tomato and orange was 21.68% and 11.32%, respectively. This result shows that 92.29% and 92.60% of the tomato and orange fruit lost an almost the same quantity of carbohydrate within the same period of time.

### Sugar Content

The initial total sugar content was assessed for tomato and orange fruit to be 0.43% and 0.65% on the day 1 of the storage, respectively, and after seven days of storage the total sugar content of the stored tomato and orange fruit was assessed to be 0.34% and 0.55%, respectively. This result shows that there is also a gradual and continuous decrease in the sugar content. This difference is may be

due to the variety difference and some other environmental conditions.

The results of the assessment in this study are good indications as they will go along in stimulating key interest in this area, especially the use of evaporative cooler as a major storage system for fruits and vegetables. The results also serve as a guide as to how long some of these products should be stored such that their nutrients are not completely lost even though they may appear attractive physically. Though physical appearance is one of the major quality parameters used in accepting or rejecting fruits and vegetables, the nutritional values cannot however be compromised. From these results it can be generally inferred that for the consumer to obtain the optimum nutrients for these products, they should not be stored beyond two weeks as the pot-in-pot storage system is concerned. However, with some careful modifications in the pot-in-pot storage system, preserving fruits and vegetables in the rural areas will be more effective in Nigeria.

### Conclusion

Important information has been generated on nutrition properties of the samples of oranges and tomatoes as they change with storage time and system. It can be concluded that these qualities generally change with time. The study revealed that there were continuous decreases in the quality parameters such as content, vitamin C, liquid, carbohydrate, protein content and total sugar content, while the value of moisture content increased with increase in storage period. However, the evaporative cooler (pot-in-pot) with some modifications can be a better alternative especially in cutting down cost of storage as far as rural communities are concerned.

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