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Effects of Household Storage on Ascorbic Acid Content of Some Selected Nigerian Vegetables

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Abstract: Effects of household preservation were assessed in five vegetables commonly consumed in major tribes of Nigeria; *Hibiscus esculentus, Corchorus olitorus, Lycopersicum esculentum, Talinum triangulare* and *Amaranthus caudatus*. The selected vegetables were purchased from local markets without knowing their maturity age and time of harvest. The wholesomeness of the vegetables was based on physical examination of their texture and colour. The vegetables were divided into two portions. In the first portion, moisture and ascorbic acid were estimated. This served as the control. The second portion was sundried and their moisture and ascorbic acid compositions determined as well. Both moisture and ascorbic acid content of the vegetables were determined using standard methods. Sun-drying decreased ascorbic acid values between 68.1 and 86.7%. Moisture losses due to sun-drying ranged between 80.1 and 96.6%. The highest moisture and ascorbic acid losses were those of *Talinum triangulare* while *Lycopersicum esculentum* and *Hibiscus esculentus* had the least losses of moisture and ascorbic acid, respectively. Sundrying adversely affected ascorbic acid in these vegetables. Nutrition education is therefore necessary to minimize loss of ascorbic acid in vegetables due to household storage methods.

Key words: Vegetables, processing, ascorbic acid, storage

INTRODUCTION

Green leafy vegetables are one of the sources of nutrients for growth in man and animal (Fasuyi, 2006). Vegetable foods provide the best fuel for our 'engine' (Pamplona-Roger, 2004). Vegetables contribute enormously to the ascorbic acid nutriture of Nigerians. They are grown throughout the year and relatively cheap and acceptable (Taylor *et al*., 1979; Addo *et al*.,1982).Variable amounts of ascorbic acid are consumed from different vegetables. The difference in quantities of ascorbic acid supplied by vegetables are negligible or enormous depending on the intrinsic factors involved in their production or as a result of post-harvest handling. After harvesting, vegetables undergo some processing and preparation for either consumption or storage. These techniques (fermentation, drying, thermal processing, freezing and cooking) are beneficial but could cause ascorbic acid losses in vegetables (Davidson and Passmore, 1986). Preservation techniques that cause dehydration and reduction of water activity are employed to increase shelf life of vegetables and ensure their availability throughout the year. Increased tropical temperature, pH and concentration expose vegetables to the risk of oxidation. Losses of ascorbic acid in vegetables during preparation, cooking and storage destroy ascorbic acid in vegetables prior to the time of consumption (Ojofeitimi and Smith, 1995). Previous studies showed that at times, values in food consumption tables for vegetables are unreliable due to various handling processes they were subjected to during preparation and storage (Black *et al*., 1983). Improved vegetable production and consumption has been recommended as the most direct, low cost method for many urban and rural poor to increase nutrient and add diversity to their diet (Chadha and Oluch, 2003).

This underscores the need to reassess the processes of preparation and storage of vegetables as regards ascorbic acid losses. Ascorbic acid in vegetables need quantification in relation to their storage methods. This is because any method of processing that retains ascorbic acid would invariably retain other nutrients.

This study was designed to quantify ascorbic acid content of selected fresh vegetables and determine the effect of sun-drying on ascorbic acid levels of the selected vegetables.

MATERIALS AND METHODS

Materials: Five (5) vegetables commonly consumed in 3 major tribes in Nigeria and usually preserved by sun-drying were chosen by purposive sampling. The vegetables were *Hibiscus esculentus, Corchorus olitorus, Lycopersicum esculentum, Talinum triangulare and Amaranthus caudatus*. These were purchased from local market as consumed without knowing their age and time of harvest. Wholesomeness was determined by physical examination of their texture and colour.

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Preparation of samples: The vegetables were divided into 2 portions labeled A and B. The first portion (A) was used to determine ascorbic acid content of fresh samples. The second portion (B) was sun-dried prior to ascorbic acid determination.

Chemical analysis

Moisture determination: The moisture content of both the fresh and processed samples were determined using an air oven method of AOAC (1990).

Ascorbic acid determination: The ascorbic acid composition of the fresh and processed samples were determined by the 2,6 dichlorophenol indophenol visual titration method (AOAC, 1990).

All the samples analyzed in each group had uniform treatment and were analyzed in triplicates.

Data analysis: The data was analyzed statistically using mean, standard deviation, one way analysis of variance and Duncan's Studentised New Multiple Range test was adopted to separate and compare means.

RESULTS

Amaranthus caudatus had the highest ascorbic acid (38.08mg/100g) which was about thrice that of *Hibiscus esculentus* (12.80MG/100G) and about double the ascorbic acid content of *Corchorus olitorus* (Table 1). *Lycopersicum esculentum and Talinum triangulare* had almost the same ascorbic acid content (25.67 and 26.25mg/100g).These values were two-thirds the amount contained in *Amaranthus caudatus*.

Talinum triangulare had the highest moisture (96.00%). The least moisture was that of *Corchorus olitorus* (81.33%). All the vegetables contained more than 80% moisture.

The mean ascorbic acid content of sun-dried samples is shown in Table 2. Sun-dried *Lycopersicum esculentum* had the highest ascorbic acid (8.17mg/100g) which was more than double the ascorbic acid content of *Talinum triangulare* (3.50mg/100g) and double that of *Hibiscus esculentus* (4.08mg/100g). The ascorbic acid content of *Lycopersicum esculentum (*8.17mg/100g) was slightly higher than that of *Corchorus olitorus (*6.42mg/100g). *Amaranthus caudatus* had the third highest ascorbic acid (5.83mg/100g).

The moisture values followed the same trend as ascorbic acid. The highest moisture (18.30%) was that of *Lycopersicum esculentum*. The value was about six times more than that of *Talinum triangulare* (3.25%) and more than double that of *Amaranthus caudatus* (8.00%). *Talinum triangulare* had the least moisture (3.25%) .

The mean ascorbic acid loss of the sundried vegetables is shown in Table 3. *Talinum triangulare* lost the highest amount of ascorbic acid after sun-drying (86.7%). This loss was as high as that of *Amaranthus caudatus* (85.1%). *Hibiscus esculentus, Lycopersicum esculentum* and *Corchorus olitorus* had similar losses of ascorbic acid after sun-drying. These losses were 75% of the losses in *Talinum triangulare* and *Amaranthus caudatus*. The vegetables retained less than 32% of their initial ascorbic acid values (fresh). However, *Talinum triangulare* and *Amaranthus caudatus* retained less than 20%.

The least moisture retention was that of *Talinum triangulare* (<5.00%). The highest moisture retention (19.9%) was in *Lycopersicum esculentum*.

Table 1: Mean moisture and ascorbic acid content of fresh vegetables

Samples	Mean Moisture content of the fresh samples (g/ 100g)	Mean Ascorbic acid content of the fresh samples (mg/100g)
Hibiscus esculentus	87.27±2.01	12.80±2.02[a]
Corchorus olitorus	81.33±2.08	19.25±1.75[a]
Lycopersicum esculentum	92.13±0.34	25.67±2.02[a]
Talinum triangulare	96.00±12.55	26.25±1.75[a]
Amaranthus caudatus	83.95±1.07	33.08±1.01[a]

Means ± S.E.M. of triplicate samples

Note: Values in the same column with same superscript letters are not significantly different ($p>0.05$)

Table 2: Mean moisture and ascorbic acid content of sundried samples

Samples	Mean moisture content of sundried samples (g/ 100g)	Mean ascorbic acid content of sundried samples (mg/100g)
Hibiscus esculentus	14.67±0.03	4.08±1.01[a]
Corchorus olitorus	10.55±0.63	6.42±1.01[a]
Lycopersicum esculentum	18.30±0.26	8.17±1.01[a]
Talinum triangulare	3.25±0.08	3.50±1.75[a]
Amaranthus caudatus	8.00±0.13	5.83±1.01[a]

Mean ± S.E.M of triplicate samples

Note: Values in the same column with same superscript letters are not significantly different ($p>0.05$)

Table 3: Mean moisture and ascorbic acid loss in the sundried vegetables

Samples	Mean moisture loss (%)	Mean ascorbic acid loss (%)
Hibiscus esculentus	83.2	68.1
Corchorus olitorus	87.0	68.6
Lycopersicum esculentum	80.1	68.2
Talinum triangulare	96.6	86.7
Amaranthus caudatus	90.5	85.1

Mean ± S.E.M of triplicate samples

DISCUSSION

Man cannot synthesise ascorbic acid. He relies solely on food sources for his ascorbic acid supply (Ojofeitimi and Smith, 1995). Thus the need to retain the ascorbic acid content of the food sources considering the enormous significance of ascorbic acid on health, especially in the prevention of cancers and cardiovascular diseases (Dragsted *et al.*, 1993; Khaw and Woodhouse, 1995). Ascorbic acid in vegetables serve as booster for the absorption of some other nutrients contained in vegetables such as iron and vitamin A (Hallberg, 1981). Vegetables rich in ascorbic acid need to be handled carefully to retain it.

Fresh samples: The high ascorbate value for *Amaranthus caudatus* (33.08mg/100g) (Table 1) relative to other vegetables studied indicated its edge over others as a better source of the nutrient. On the other hand, the comparable ascorbate (25.67mg/100g and 26.25mg/100g) for *Lycopersicum esculentum* and *Talinum triangulare* suggests that any of them could supply equal amount of the nutrient on wet weight basis. *Hibiscus esculentus* appears to be the least source of ascorbate (12.80mg/100g) followed by *Corchorus olitorus* (19.25mg/100g) on wet weight basis. Combinations of two or more of these vegetables could synergistically contribute the much desired ascorbate in our daily diets.

The ascorbic acid values for fresh *Talinum triangulare, Corchorus olitorus* and *Hibiscus esculentus* obtained in this study were lower than those reported by Keshinro and Ketiku (1979) and Keshinro (1980). The variations in ascorbate could be attributed to: (a) varietal differences (b) level of maturity and (c) soil types. These variables could be responsible because the vegetables were bought in the open market. Another reason for the variation in ascorbate could be bruises and wilting which the vegetables were exposed to. These factors predispose ascorbate to oxidation (Pelletier *et al.*,1977). These conditions could cause a difference in ascorbic acid even in the same species of vegetables (Taylor *et al.*,1979). The magnitude of these losses depends on the production and handling procedures (Shewfelt, 1990).

The mean ascorbic acid value of 39.08±1.01 mg/ 100g for fresh *Amaranthus caudatus* was similar to 41.14±1.73 mg/100g reported by Keshinro and Ketiku (1979) and 32.90±1.80mg/100g fresh weight reported by Keshinro (1980) for the same vegetable. This value also falls within the range of 36.5 to 85mg/100g fresh weight reported by Taylor et al (1979) for the same vegetable at 5-7 weeks of age. The differences in values for ascorbic acid of other vegetables considered in this study with those given by Taylor *et al.* (1979) could be accounted for by differences in maturity of the vegetables. This is because ascorbic acid in vegetables is influenced by maturity (Tannenbaum, 1976). An ample consumption of ascorbic acid rich vegetables could be a ready tool towards addressing other health problems such as iron deficiency anaemia and infections (Hertrampf *et al.*, 1991; Khaw and Woodhouse, 1995).

The moisture values for these fresh vegetables agree with 65-96% reported by USDA (1984). These vegetables could be used in low energy density diets for patients on weight reduction regimens.

Sundried samples: Drying is a preservative procedure employed in the household to ensure a sustained supply of vegetables during periods of low production and scarcity. It implies the exposure of sliced and unsliced vegetables to solar energy in the tropics. The high ascorbic acid loss in the sundried samples (Table 3) is attributable to the oxidative effect of increased temperature on ascorbic acid (Pelletier *et al.*,1977). This study found that as much as 86% of initial ascorbic acid can be lost on sundrying of vegetables and the longer the drying, the more the loss. It was more than the values of between 16.67 and 64.68% losses reported by Oboh and Akindahunsi (2004) and 64% reported by Faboya (1990) for ascorbic acid losses when vegetables were exposed to the direct rays of the sun for 8 hours. This could be as a result of variations in the drying temperature and length of drying. However, the result agrees with the finding of Aworh *et al.* (1983) that a significant amount of the initial ascorbic acid of fresh vegetables was lost on exposure to increased temperature. This study also found a positive correlation between the moisture and ascorbic acid loss during sundrying. Udofia and Obizoba (2005) reported that sun and shade drying reduced the moisture and dry matter of vegetables. The variable time frames needed for the complete vaporization of the moisture content affected the time of drying and the level of ascorbic acid loss. Hence, the more succulent vegetables were more susceptible to higher losses of ascorbic acid than the resilient vegetables when dried under the sun.

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