# THE EFFECT OF PROCESSING ON ASCORBIC ACID AND DEHYDROASCORBIC ACID IN DIFFERENT VARIETIES OF YAM (DIOSCOREA ROTUNDATA, D. CAYENENSIS)

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## ABSTRACT

The effect of some processing method on the ascorbic acid and dehydroascorbic acid content of two cultivars of yam (*Dioscorea rotundata* and *D. cayenensis*) were investigated. The processing method adopted were cooking, frying and roasting. The assay of ascorbic acid in the two cultivars ranged from (5.0 – 9.2 mg/100g fresh tissue). The moisture contents of the processed samples ranged from 40-55% for *D. rotundata* and 48-60% for *D.cayenensis* except for roasted samples which had a moisture content of 30% for the two cultivars of yam. The pH values were similar in all the varieties examined. The level of ascorbic acid after 0-8 days of storage ranged from 5.2 -7.3mg/100g fresh tissue on a moisture -free basis (mfb). The dehydroascorbic acid content varied from 5.0-9.2 mg/100g fresh tissue on a moisture-free basis. The retention in ascorbic acid and dehydroascorbic acid of the various treatments ranged from 4.9 - 6.2mg/100g and 5.2- 8.9mg/100g respectively. Thus, different processing methods has contributed to the loss of ascorbic acid with the highest loss observed when the yam samples were roasted and least loss when they were fried.

Keywords: Ascorbic acid, Dehydroascorbic acid, D. cayenensis and D. rotundata.

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## INTRODUCTION

Yam is one of the staple foods in Nigeria and other tropical African countries. Yams are members of the genus *Dioscorea*. *Dioscorea* is the largest genus of the family Dioscoreaceae, containing between three and six hundred species (Vernier *et al*., 1998). Annual world production of yam is about 40 million tonnes and per capita consumption is estimated to be 256.4 g per day in the major production zones (FAOSTAT, 2005).

Yam is grown and cultivated for its energy-rich tuber. Only a few species of yams are cultivated as food crops. The most important species of *Dioscorea* include *D. rotundata, D. alata, D. cayenensis, D. dumetorum, D. esculenta and D. bulbifera. Dioscorea alata*, called "water yam", "winged yam" and "purple yam", is the species most widely spread throughout the world and in Africa is second only to white yam in popularity (Mignouna *et al.,* 2004).

Yam is of higher nutritional value than some other root and tuber crops such as cassava. Its protein content is about 3 - 6% as compared to 1 - 2% in cassava (Charles *et al*., 2004). Yams are reported to contain relatively high levels of minerals (Afoakwa and Sefa-Dedeh, 2001). Yams are also known to contain some antinutritional components that may have adverse effects on human nutrition (Dipak and Mukherejee, 1986). These are mainly tannins, phenols and phytic acid.

Two principal traditional methods used for preparing yams for consumption in coastal West Africa, especially Nigeria, are boiling tuber pieces and pounding into a dough after boiling (Omonigho and Ikenebomeh, 2000). Several traditional household food-processing methods can affect the bioavailability of nutrients in plant-based diets. These include thermal processing, mechanical processing, soaking, fermentation and germination, (Hotz and Gibson, 2007).

Ascorbic acid is a water-soluble vitamin, well recognized as an anti-scorbutic food factor. Ascorbic acid oxidation to DHAA is the most prominent chemical property of the vitamin. The two biologically active forms of vitamin C present naturally in foods are L-ascorbic acid and L-dehydroascorbic acid (Christie and Wiggins, 1978). Vitamin C is an important part of yam tuber, it occurs in quantities large enough to make major contribution to human nutrition in areas where yam are intensively consumed. The objective of this study is to determine the effect of processing on ascorbic acid and dehydroascorbic acid level in different varieties of yam.

## .MATERIALS AND METHODS

Two cultivars of yam tuber namely *Dioscorea Rotundata* (white yam), *D. Cayenensis* (yellow yam) were obtained directly from Owena market in Osun state, Nigeria. A re-modified methods described by Hampson, were employed for the processing of yam tubers. The tubers were peeled, washed and cut into cubes of about 2cm and subjected to different treatments. Fifty (50kg) of the yam tuber cubes/dices were cooked for 15minutes in aluminum pot, pressure cooked (15psi, $121^0$c) for 10 minutes, fried, cooked by steaming for 12minutes and roasted for 30 minutes.

**Chemical analysis**

The moisture content and pH level of the samples were determined in triplicate according to the method of AOAC (2005). The dye-titration method was used to determine the ascorbic acid and dehydroascorbic acid (AOAC, 2005). Metaphosphoric acid extracts of the foods were prepared and pH adjusted to about 1.2. The reducing capacity of the extracts was then measured by titrating with 2, 6-dichlorophenolindophenol (DCIP). In this oxidation-reduction reaction, ascorbic acid in the extract was oxidised to dehyroascorbic acid and the indophenol dye reduced to a colourless compound. End point of the titration was detected when excess of the unreduced dye gave a rose pink colour in acid solution.

**Statistical Analysis**

The data obtained were subjected to Analysis of variance (ANOVA) using statistical package for social science (SPSS version 15.0) to detect significant difference at $p< .005$. Significant means were separated using Turkey's least significant differences (LSD) test.

## Result and Discussion

The levels of ascorbic acid (AA) and dehydroascorbic acid (DAA) from 0 - 8days of storage are shown in Table 1. At room temperature there was a reduction in the ascorbic acid level to about 72% of the original value in 5 days. After 8 days of storage the ascorbic acid content dropped to insignificant levels. There was a general increase in the level of DAA in the stored samples indicating that some of the AA was converted to DAA.

**Table 1: Changes in the levels of ascorbic acid in D.rotundata and D.cayenensis**

| Raw yam | DAYS | AA | DAA |
|---|---|---|---|
| White yam | 0 | $7.3\pm1.00^{c}$ | $6.8\pm1.00^{a}$ |
| | 5 | $5.3\pm1.00^{b}$ | $8.7\pm1.00^{b}$ |
| | 8 | $5.2\pm1.00^{a}$ | $9.2\pm1.00^{c}$ |
| Yellow yam | 0 | $6.7\pm1.00^{c}$ | $5.0\pm1.00^{a}$ |
| | 5 | $5.4\pm1.00^{b}$ | $6.4\pm1.00^{b}$ |
| | 8 | $5.3\pm1.00^{a}$ | $7.8\pm1.00^{c}$ |

Means in the same column with different superscripts are significantly different at $p < .005$.

AA- ascorbic acid

DAA- dehydroascorbic acid

The results of the moisture content and pH level are presented in (table 2). The moisture content of the various treatments ranged from 30 – 60%; cooked yam has the highest moisture content while roasted yam has the lowest moisture content along the various treatments. The increase in the moisture content of cooked yam, steam cooked yam and pressure cooked yam depends on the cooking time of each treatment. Cooked yam has the highest cooking time (20 minutes) which aids the absorption of water in the treated sample; roasted yam has the lowest moisture content due to high temperature treatment for 30 minutes. This treatment yields a significant loss in the moisture content of the sample. The pH value of the various treatments varies from 4.67 – 5.83 mol/l. The retention in AA of the various treatments ranged from 4.9 - 6.2 mg/100g respectively. There is no significant difference between steam cooked yam, cooked yam and pressure cooked yam because ascorbic acid has been dissolved in water during the treatment. Fried yam retained a substantial amount of ascorbic acid in the sample than roasted yam because roasted yam are subjected to high temperature for a long time (30 minutes) which reduces the level of ascorbic acid in the sample. The DAA level of the various treatment ranged from 5.2- 8.9. Increase in the level of DAA along various samples is as a result of conversion of AA to DAA during processing.

**Table 2: Effect of Processing on Moisture and pH level of Yam Varieites**

| | Dioscorea rotundata | | Dioscorea cayenensis | |
|---|---|---|---|---|
| Treatment | moisture (%) | pH (mol/l) | moisture (%) | pH(mol/l) |
| Roasted yam | $30.67 \pm 1.00^{a}$ | $5.73 \pm 0.32^{d}$ | $30.00 \pm 1.00^{a}$ | $5.73 \pm 0.16^{c}$ |
| Fried yam | $40.00 \pm 1.00^{b}$ | $4.53 \pm 0.74^{b}$ | $48.00 \pm 1.00^{b}$ | $4.67 \pm 0.36^{a}$ |
| Raw yam tuber | $44.33 \pm 1.00^{c}$ | $4.10 \pm 1.00^{a}$ | $52.33 \pm 0.17^{c}$ | $4.73 \pm 0.36^{a}$ |
| Pressure cooked yam | $50.67 \pm 1.00^{d}$ | $4.87 \pm 1.00^{c}$ | $56.33 \pm 1.00^{d}$ | $5.13 \pm 1.00^{b}$ |
| Steam cooked yam | $52.67 \pm 1.00^{e}$ | $5.63 \pm 0.32^{d}$ | $53.33 \pm 0.17^{c}$ | $5.83 \pm 0.16^{c}$ |
| Cooked yam | $55.33 \pm 1.00^{f}$ | $4.50 \pm 0.74^{b}$ | $60.33 \pm 1.00^{e}$ | $4.67 \pm 0.36^{a}$ |

Means in the same column with different superscripts are significantly different at $p < .005$.

**Table 3: Effect of processing on level of ascorbic acid and dehydroascorbic acid**

| | | Dioscorea rotundata | | Dioscorea cayenensis | |
|---|---|---|---|---|---|
| Treatment | Time (min) | AA | DHAA | AA | DHAA |
| Cooking | 15 | $5.3 \pm 0.25^{b}$ | $6.3 \pm 0.38^{b}$ | $5.4 \pm 1.00^{b}$ | $8.3 \pm 1.00^{c}$ |
| Pressure cooking | 12 | $5.4 \pm 0.25^{b}$ | $6.5 \pm 0.38^{c}$ | $5.4 \pm 1.00^{b}$ | $8.5 \pm 1.00^{b}$ |
| Steam cooking | 20 | $5.4 \pm 0.25^{b}$ | $6.2 \pm 0.38^{b}$ | $5.4 \pm 1.00^{b}$ | $8.5 \pm 1.00^{b}$ |
| Frying | 4 | $6.2 \pm 1.00^{c}$ | $6.5 \pm 0.38^{c}$ | $5.8 \pm 1.00^{c}$ | $8.9 \pm 1.00^{d}$ |
| Roasting | 30 | $4.9 \pm 1.00^{a}$ | $5.5 \pm 1.00^{a}$ | $5.0 \pm 1.00^{a}$ | $5.2 \pm 1.00^{a}$ |

Means in the same column with different superscripts are significantly different at $p < .005$.

**Conclusion and Recommendation**

The result shows that cooking, especially roasting, leads to greater loss of ascorbic acid and dehydroascorbic acid. For maximum retention of ascorbic acid, yam tubers should be processed immediately after harvesting as ascorbic acid decreases rapidly during storage. Since surface areas enhance loss of ascorbic acid, the yam tubers should be cooked whole before peeling as being practiced by some local processors. This measure will greatly reduce leaching of nutrients into cooking; however it may require higher energy and cost.

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