



The Effect of Processing on Ascorbic Acid and Dehydroascorbic Acid in Different Varieties of Yam

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Authors' contributions

This work was carried out in collaboration between both authors. Author OIO designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author SOO managed the literature searches. Both authors read and approved the final manuscript.

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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 / 100 g 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 - 7.3 mg / 100 g fresh tissue on a moisture -free basis (mfb). The dehydroascorbic acid content varied from 5.0 - 9.2 mg / 100 g fresh tissue on a moisture- free basis. The retention in ascorbic acid and dehydroascorbic acid of the various treatments ranged from 4.9 - 6.2 mg / 100 g and 5.2 - 8.9 mg / 100 g 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.

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1. 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 [1]. 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 [2].

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 [3].

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 [4]. Yams are reported to contain relatively high levels of minerals [5]. Yams are also known to contain some antinutritional components that may have adverse effects on human nutrition [6]. 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 [7]. 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 [8].

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 [9]. 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. Thus, different processing methods pose various threats to the

retention of Vitamin C in the processed tubers. The objective of this study is to determine the extent of loss of the vitamin during post-harvest storage, cooking, frying and roasting.

2. 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 [10], were employed for the processing of yam tubers. The tubers were peeled, washed and cut into cubes of about 2 cm and subjected to different treatments. Fifty (50 kg) of the yam tuber cubes/dices were cooked for 15minutes in aluminum pot, pressure cooked (15 psi, 121⁰c) for 10 minutes, fried, cooked by steaming for 12 minutes and roasted for 30 minutes.

2.1 Chemical Analysis

The moisture content and pH level of the samples were determined in triplicate according to the method of AOAC [11]. The dye-titration method was used to determine the ascorbic acid and dehydroascorbic acid [11]. 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 dehydroascorbic 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.

2.2 Statistical Analysis

Data obtained from the study were subjected to Analysis of variance ($p < .005$). The data generated were expressed as mean \pm standard deviation. Statistical comparison were performed using SPSS version 15.0.

3. RESULTS AND DISCUSSION

The levels of ascorbic acid (AA) and dehydroascorbic acid (DAA) from 0 – 8 days 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

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±1.00 ^c	6.8±1.00 ^a
	5	5.3±1.00 ^b	8.7±1.00 ^b
	8	5.2±1.00 ^a	9.2±1.00 ^c
Yellow yam	0	6.7±1.00 ^c	5.0±1.00 ^a
	5	5.4±1.00 ^b	6.4±1.00 ^b
	8	5.3±1.00 ^a	7.8±1.00 ^c

Means in the same column with different superscripts are significantly different at $p < .005$
AA- ascorbic acid; DAA- dehydroascorbic acid

Table 2. Effect of processing on moisture and pH level of yam varieites

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

Treatment	Time (min)	<i>Dioscorea rotundata</i>		<i>Dioscorea cayenensis</i>	
		AA	DHAA	AA	DHAA
Cooking	15	5.3±0.25 ^b	6.3±0.38 ^b	5.4±1.00 ^b	8.3±1.00 ^c
Pressure cooking	12	5.4±0.25 ^b	6.5±0.38 ^c	5.4±1.00 ^b	8.5±1.00 ^b
Steam cooking	20	5.4±0.25 ^b	6.2±0.38 ^b	5.4±1.00 ^b	8.5±1.00 ^b
Frying	4	6.2±1.00 ^c	6.5±0.38 ^c	5.8±1.00 ^c	8.9±1.00 ^d
Roasting	30	4.9±1.00 ^a	5.5±1.00 ^a	5.0±1.00 ^a	5.2±1.00 ^a

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

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.

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 / 100 g 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.

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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