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Effects of Blanching on Mineral, Vitamins and Some Physico-chemical Contents of Products from African Star Apple (Chrysophyllum albidium) Peels and Cotyledons.

Eze, J. I., Okafor, G. I. and Okoyeuzu, C. F.

ABSTRACT

This study focuses on the identification of the minerals, vitamins and physico-chemical contents in the peels and cotyledons of Afrian star apple (Chrysophyllum albidium) and evaluate the effects of processing on the chemical properties of their products. The peels and cotyledons were blanched at 1000C for 2,4 and 6 mins, wet milled with water in 1: 1.5 ratio, sieved with muslin cloth to obtain the extracts which were pasteurized at 800C for 10mins thus giving rise to 8 samples including their control samples coded as follows: peel extract control samples (A1, B1 and C1) of 2, 4 and 6 mins blanching respectively and cotyledons extract control samples (A_2, B_2 and C_2) of 2, 4 and 6mins blanching respectively. The fresh peel and cotyledon contains the following vitamin E (4.80% and 19.00%), vitamin C (3.85% and 13.75%) and vitamin A (3.48% and 64.52%); minerals such as; sodium (205.25% and 281.44%), calcium (0.04% and 0.065%), iron (0.82% and 1.05%) and zinc (42.12% and 79.00%), respectively which reduced with increased blanching period. The physico-chemical contents; soluble protein (0.54% and 0.710%) and total soluble carbohydrate (TSC) (45.74% and 48.57%) - in both fresh peels and cotyledons respectively also reduced appreciably with increased blanching period. While ph (3.17% and 4.87%) contents in fresh peel and cotyledon respectively increased with increase in blanching periods, total soluble solids (TSS) (0.12% and 0.02%) contents in fresh peel and cotyledon respectively increased during 2mins blanching and decreased afterwards.

Key words: Blanching, minerals, physico-chemical, vitamins.

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INTRODUCTION

Chrysophyllum albidium, from the Sapotaceae family, is commonly found in the Central, Eastern and Western Nigeria, Uganda, Niger, Cameroon, and Cote d'Ivoire (Adewusi, 1997). It is often called the white star apple and distributed throughout the Southern part of Nigeria (Idowu *et al.*, 2006). In Westhern Nigeria, the fruit is called "agbalumo" and popularly referred to as "udara" in South-Eastern Nigeria. *C. albidium* is a popular tropical fruit tree and widely distributed in the low rain forest zones and frequently found in villages (Madubuike and Ogbonnaya, 2003). The roots, barks and leaves of *C. albidium* have been employed in folk medicine for the treatment of diseases. The fruit is seasonal (December-March) and has immense economic potentials (Essien *et al.*, 1995), when ripe, ovoid to subglobose, pointed at the apex, and up to 6cm long and 5cm in diameter. The skin or peel is orange to golden yellow when ripe and the pulp within the peel may be orange, pinkish or light yellow. Within the succulent pulp are three to five seeds which are usually eaten. The seed-coats are hard, bony, shiny, and dark brown, and when broken reveal white-coloured cotyledons (Essien *et al.,* 1995). The peel contains minerals (in mg/100g dry matter) namely calcium, 250; potassium, 1175; sodium, 12; copper, 20; magnesium, 90; zinc, 3.8; iron, 200; and phosphorus, 76.8. The pulp contains (in mg/100g dry matter) namely; calcium, 100; potassium 1175; sodium, 10; copper, 2.0; magnesium, 75; zinc, 3.2; iron, 10; and phosphorus, 75.4. The peel contains ascorbic acid 239.1

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mg/100g and the pulp, 446.1 mg/100g (Edem *et al.*, 2003) (Table 1). The seed is low in minerals.

Table 1a: Minerals content of peel and pulp of African star apple (in mg/100g)

	Ca	K	Na	Mg
Peel	230	11.75	12	90
Pulp	100	11.75	10	75

Source: Edem et al., (2003)

Table 1b: Minerals content of peel and pulp of African star apple (in mg/100g)

	Zn	Fe	P	Cu
Peel	3.8	200	76.8	2.0
Pulp	3.2	10	75.4	2.0

Source: Edem *et al.*, (2003)

MATERIALS AND METHODS

MATERIALS : Procurement of Raw Materials

The healthy fruits of *Chrysophyllum albidum* were collected from uncultivated and cultivated farmlands respectively, located at South Eastern part of Nigeria.

Reagents for Laboratory Analysis

All reagents used for this study were obtained from the Department of Food Science and Technology University of Nigeria, Nsukka and Ogige Market in Nsukka respectively and they are all of analytical quality.

METHODS

Sample Preparation

The fruits were thoroughly washed with water, to remove extraneous materials such as dirt, separated into pulp, peel and seeds which were further cracked to reveal the white cotyledon. Different processing methods were applied as shown in Fig. 1.

Production of Extracts from Blanched Cotyledons and Peel.

The cotyledon and peel were divided into three equal parts each and steam blanched at 100°C for 2mins, 4mins and 6mins, wet milled to produce their respective pulps which were blended with water in 1:1.5 ratios producing their extract yield respectively. These extracts were pasteurized at 80°C for 10mins and thereafter bottled for analyses thus giving rise to 8 samples including their control samples coded as follows: blanched peel extract samples (A_1, B_1 and C_1) of 2, 4 and 6 mins blanching respectively and blanched cotyledons extract samples (A_2, B_2 and C_2) of 2, 4 and 6mins blanching respectively.

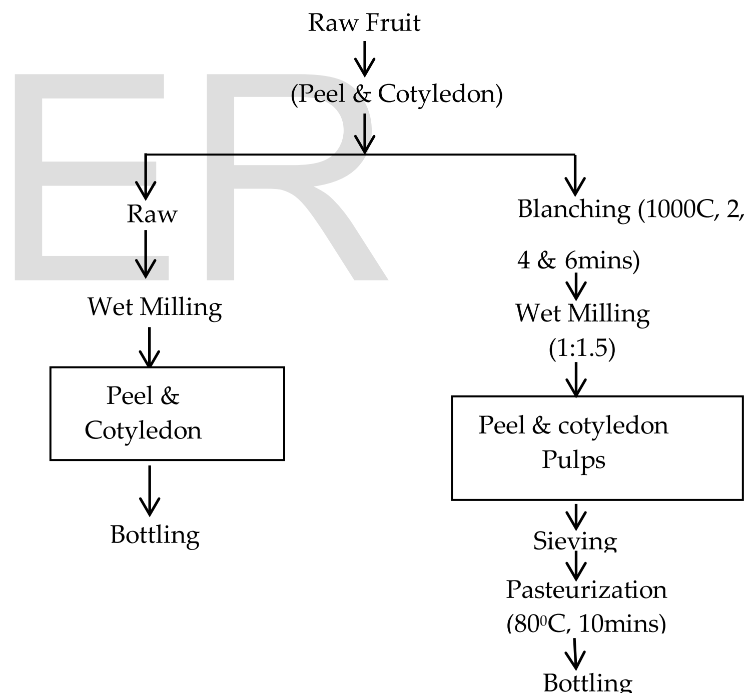

Fig. 1: Production of udara products.

SAMPLE ANALYSIS

Determination of Vitamin A

The colorimetric method of AOAC (2010) method was adopted. This measures the unstable colour at the absorbance of 620nm that result from the reaction

between vitamin A and $SbCl_3$. Pyrogallol (an antioxidant) was added to 2g sample prior to saponification with 200ml alcohol KOH. The saponification took place in water bath for 30 minutes. The solution was transferred to a separator funnel where water was added. The solution was extracted with 1.0 to1.5ml of hexane. The extract was washed with equal volume of water. The extract was filtered through filter paper containing 5ganhydrous Na_2SO_4 into volumetric flask. The filter paper was rinsed with hexane and make up to volume. The hexane was evaporated from the solution and blank. About 1ml chloroform and $SbCl_3$ solution was added to the extract and blank. The reading of the solution and blank was taken from the colorimeter adjusted to zero absorbance or 100%.

Calculation

mg Vitamin A = A620mm x Sl x (v/wt)

Where A620nm – absorbance at 620nm

Sl: Slope of standard curve (vit. A conc.)/A620 reading)

V: Final volume in colorimeter tube

Wt: Weight of sample.

Determination of Vitamin C

Adopting the method of AOAC (2010), Vitamin C was determined by first preparing stock ascorbic acid solution. This was done by preparing 0.1 solution of ascorbic acid in 0.4% oxalic acid solution. The working standard (WS) was prepared by taking 5, 10, 15, 20 and 25ml of stock ascorbic acid solution and made up to 500ml with 0.4% oxalic acid solution. These solutions numbers 1 – 5 for each sample contained1, 2, 3, 4 and 5 mg ascorbic acid per 100ml respectively. Standard dye solution was prepared by adding 12mg of 2, 6-dichlorophenolindophenol to 1 litre of the sample solution. In order to obtain a standard curve, four (4) adsorptiometer tubes were added into it the following:

DW – 10ml water

No. 1 – 1ml 0.4% of oxalic acid

S – 1ml WS No. 14 9ml water

No. 2 – 1ml WS No.1

The absorptiometer was adjusted to zero using distilled water (DW) and a green filter (aprox. 520mμ). To tube No. 1, 9ml standard dye solution (0.0012%) was added mixed and the reaction recorded (L_1) at exactly 15 seconds after adding the dye. The instrument was adjusted to zero with tube S in the absorptiometer. To tube NO.2, 9ml dye was added, mixed and read after 5 seconds (L_2). L_1 and L_2 were recorded for each working standard and standard curve constructed with the concentration of ascobic acid (mg/100ml) as abscissae and $L_1 - L_2$ for each working standard as ordinates.

Fifty (50g) sample was macerated for 3 minutes in a blender (Kenwood, England) with 350ml of 0.4% oxalic acid solution and filtered. L_1 was obtained as described above in tube S, 1ml filtrate of 9ml water was added and the instrument adjusted to zero. Then, to tube No 2, 1ml filterate of 9ml dye was added and recorded L_2 after 15 seconds. $L_1 – L_2$ was calculated and the concentration of ascorbic acid obtained from the standard curve.

Determination of Vitamin E

Vitamin E was determined by Pearson (1976) method. About 1g of sample into a 100ml flask and 10ml of absolute alcohol was added. Also, 20mls of 2M alcoholic tetraxosulphate VI acid (H_2SO_4). Then, 10ml of the clear solution into a test tube was pipetted. Heating was done in a water bath at 90°C for 3 minutes and allowed to cool. The absorbance was read using a spectrophotometer at 470nm wavelength. However, the

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blank and the standard vitamin E solution was prepared. The vitamin E was calculated at 470nm wavelength as shown below:

$$\text{Vitamin E in mg/100 g} = \frac{a-b}{S-b} \times \frac{C}{W}$$

Where:

a. = absorbance of test sample
b. =absorbance of the standard solution
c. = concentration of standard in mg/100g
w = weight of the sample used.

Determination of Riboflavin

Riboflavin was determined according to the method of AOAC (2010). 2.0g weight of food material containing about 5-10mg of riboflavin in a conical flask was taken. About 50ml of 0.2N HCl was added and boiled in a water bath for 1hr. The solution was cooled and the pH adjusted to 6.0 using NaOH. About 1N HCl was added to lower the pH to 4.5, then filtered in a 100-ml measuring flask and used to make volume up to mark. To remove interference, two tubes were taken and labeled 1 and 2 for tube 1 and 10ml of filtration and 1ml of water for tube 2 respectively. Then, 10ml of filtrate was added to 1ml of riboflavin standard. About 1ml of acetic acid (glacial) was added to each tube, mixed and then 0.5ml of 3% $KMnO_4$ solution was added. The solution was kept away for 2 min and then 0.5ml of 3% H_2O_2 added and mixed well. The flourimeter was adjusted to excitation wavelength of 470nm and emission wavelength of 525nm. Also, the flourimeter was adjusted to zero deflection against 0.1N H_2SO_4 and 100 against tube 2. The fluorescence of tube 1 was measured. About 20mg of sodium hydrogen sulphate was added to both tubes and fluorescence measured within 10 seconds and recorded as blank readings.

Calculation:

W = Weight sample

X = (reading of sample 1) – (reading of sample blank)

Y = (reading of sample + standard tube 2) – (reading of sample + standard blank)

Riboflavin (mg per sample) $= \frac{x}{Y-x} \times \frac{1}{w}$

Mineral Content Determination

The minereals were determined using the method of AOAC (2010). Two grams sample was weighed into porcelain crucible and ashed for 3 hours at 600°C. After cooling the ash was dissolved in 10ml conc. HCl and filtered. The filtrate was added into 100-ml volumetric flask and made up to 100ml. This was known as stock solution.

Iron Determination

Phenanthroline method was used. Digested sample (5ml) was added in a test-tube. Then, 3ml of phenanthroline solution and 2ml of HCl was added; 1ml of hydroxylamine solution was added to the mixture and boiled in a steam bath at 600°C for 2 minutes. Afterwards, 9ml of ammonium acetate buffer solution was added and diluted to 50ml with water. The absorbance was taking at 510nm.

Phenanthroline solution was prepared by dissolving 100mg I,10-phenanthroline molybdate in 100ml distilled water by stirring and heating to 80°C. Hydroxylamine solution was prepared by dissolving 10g in 100ml of distilled water, while ammonium acetate buffer solution was prepared by dissolving 250g in 150ml distilled water.

Calibration curve was prepared by pipetting 2, 4, 6, 8, and 10ml standard iron solution into 100-ml volumetric flasks to prepare a solution of known concentrations. The curve obtained was used to read off the value of iron.

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Determination of Calcium

A 25.oml of the sample was pipette into conical flask, a pinch of EBT was added, 2ml of the NaOH solution was also added and the mixture titrated with standard EDTA solution

$$(Mg/L) / ppm\ Ca = \frac{T \times M \times E \times 1000}{\text{Volume of sample used.}}$$

Where T =Titre value
M = Molality of EDTA
E = Equivalent weight of calcium

Sodium Determination

Sodium content of the "udara" extracts were determined using flame photometer apparatus. About 2.5ml of the analyzed fluid was measured into a 100-ml graduated flask and diluted to the 100ml mark. The flame photometer was set up according to the instruction provided and the sample solution then aspired and the reading (%E- emission) recorded).

The Calculation:

$$\% = \frac{ppm \times 100 \times DF}{1000000}$$

Where: DF – Dilution Factor

Zinc Determination

Zinc was determined using the method of Dithizone. To 5ml of the digested sample, 5ml of acetate buffer was added in a test tube. Also 1ml of sodium thiosulfate solution was added into it and shaken vigorously for 4mins. The absorbance was read at 535nm. However the standard was prepared and used to find the concentration of the sample.

Determination of Soluble Protein

This was done using the method as described by Obanu (1978). About 0.2g of the sample was weighed into a test tube containing 20ml of 3% sodium deodeylsulphate (SDS) and 1% β-mecarpto ethanol. The mixture was allowed to stand at room temperature for a period of 30 minutes and then filtered hot. The residue represents the insoluble fraction. The nitrogen content of each sample (fraction) will be determined using the micro-Kjeldahl distillation technique. The nitrogen content of the filtrate T_1 and the residue T_2 was used to calculate the percentage soluble protein.

$$\%\ \text{Soluble protein} = \frac{T_1}{T_1+T_2} \times \frac{100}{1}$$

Determination of Total Soluble Carbohydrate

Total soluble carbohydrate was determined according to the method of AOAC (2010). A 2g of each flour sample was weighed into a 250-ml beaker containing 100ml of 80% ethanol. The solution was heated in a water bath at 80^0C for 1hr, cooled and decanted into a 1000-ml beaker. The process was repeated three times and the combined extracts was evaporated to 200ml. A 5ml of 10% lead acetate was added and mixed thoroughly. The solution was left to stand for 20min, filtered through Whatman No. 1 filter paper and stored as sugar extract. From the sugar extract, 5ml was pipette into a pyrex, test-tube and 2ml of 5% phenol and 10ml of concentrated H_2SO_4 added. The content was mixed and allowed to stand for 10min to cool to room temperature. Absorbance of the solutions was determined at 490nm against a reagent blank using a spectrophotometer (Spectronic 21). Sugar quantities were estimated using calibrated standard graphs.

Soluble Solids Determination

This was determined by the method described by AOAC (2010). A properly mixed 1gram sample in 20ml distilled water was filtered using Whatman No. 1 filter paper. The filtrate was transferred into a weighed evaporating dish and evaporated to dryness in a drying oven. The evaporated sample was dried for 1hr at

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103^{0}C. The dish was cooled in a dessicator and weighed. Drying at 103^{0}C and weighing were repeated until a fairly constant weight was obtained. Total soluble solids were calculated as follows:

$$\text{Total soluble solids (\%)} = \frac{(\text{Wt of dried filtrate + dish}) - (\text{Wt. of dish})}{\text{Wt of sample used}} \times \frac{100}{1}$$

Data Analysis and Experimental Design

The results were laid out in a completely randomized design (CRD) using a statistical programme SPSS/PC+, Version 17.0 (SPSS Inc., Chicago, IL, USA). A one-way ANOVA was employed for comparison among the groups. Duncan's new multiple range test (DNMRT) was used to compare the treatment means and significance level was accepted at 5%.

RESULTS AND DISCUSSION

Effect of Blanching on the Vitamin Contents of "Udara" Peel and Cotyledon Samples

The vitamin contents of "udara" peel and cotyledon samples are presented in Table 2a and 2b. The vitamin E (tocopherol) values of the samples were found to be 4.80mg/100g and 19.00mg/100g for fresh peel and cotyledon respectively. These values reduced appreciable, in the processed samples which agreed with the report of Ottaway (1993) and Audrey *et al*. (2004) that vitamin E was heat-labile in the presence of air. Thus vitamin E contents of the products were significantly high because of its antioxidant property that plays a role in protecting the lungs from air pollutants and secondly protects red blood cell membranes from the effects of oxidizing agents and air pollutants (Wardlaw and Kessel, 2002).

Blanching had varying effects on the vitamin C content of samples, which were found to be significantly different ($p<0.05$) with blanching except for fresh peel (3.85%) and 2mins blanched extract (3.58%). Generally vitamin C contents of fresh cotyledon and its extracts were higher than that of fresh peel samples. These vitamin losses are in line with the report of Oboh (2005) that food processing methods (pasteurization and heat treatments) would reduce the vitamin C contents, as well as Audrey *et al.* (2004) who observed that heating and cell damage (milling, chopping, or slicing) decrease vitamin C.

The lower vitamin C contents of the extracts in relation to fresh cotyledon and peel samples could be attributed to dilution effect and loss during pasteurization (Nagy and Smooth, 1977). Owen (1996) also reported that because of its high solubility, the potential existed for significant losses by leaching during blanching. Since "udara" is a good source of vitamin C (Okafor, 1975). It can help in the collagen and hormonal synthesis and scurvy prevention. Also its biological antioxidant effect plays a role in cancer prevention (Enwere, 1998). Thus, the vitamin C content of these products can augment the recommended dietary allowance value for vitamin C (60mg) as specified in Hahn and Payene, (1997). Its antioxidant role also protects the membrane erythrocyte, maintains blood vessel flexibly, and improves blood circulation in the arteries of smokers and facilitates the absorption of iron in the body (Guyton and Hall, 2006).

The vitamin A content of fresh cotyledon was significantly ($P>0.05$) higher (64.52 IU) than that of peel (3.48 IU). There was no significant difference ($P>0.05$) among blanched cotyledon extracts while extract of peel recorded trace amounts. These reduction

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compared to their fresh samples, could be attributed to dilution effect associated with handling during processing. Vitamin A as an antioxidant plays a major role in vision. The vitamin A contents of the products were not within the recommended daily intake (RDI) of 3000 – 10, 000 IU as specified in Nestle (2000).Vitamin B_2 (riboflavin) content was not obtained in any of the sample.

Table 2a: Effects of blanching on the vi tamin content of African star apple "udara" samples.

Vitamins	Peel	A1	B1	C1
E(mg/ 100g)	4.80± 0.28b	2.92± .03cd	2.50± 0.03d	0.50± 0.03f
C (%)	3.85± 0.06	3.58± 0.04c	2.08± 0.06e	0.57± 0.03f
A (Iu)	3.48± 0.07c	ND	ND	ND

Values are means± SD (n= 3). Mean values with the same superscript in a row are not significantly different (p > 0.05). ND=Not detected.

Table 2b: Effects of blanching on the vi tamin contents of African star apple "udara" samples.

Vitamins	Seed	A2	B2	C2
E (mg/100g)	19.00±0.99a	3.80±0.57bc	2.00±0.03de	1.20±0.03ef
C (%)	13.75±0.35	4.54±0.07b	2.61±0.04d	0.68±0.07f
A (Iu)	64.52±0.06a	13.10±0.00b	13.10±0.00b	13.10±0.00b

Values are means± SD (n= 3). Mean values with the same superscript in a row are not significantly different (p > 0.05). ND=Not detected.

Key
A1- 2mins blanched extract of "udara" peel.
B1- 4mins blanched extract of "udara" peel.
C1- 6mins blanched extract of "udara" peel.
A2- 2mins blanched extract of "udara" cotyledon.
B2- 4mins blanched extract of "udara" cotyledon.
C2- 6mins blanched extract of "udara" cotyledon.

Effects of Blanching on Mineral Compositions of "udara" samples

The result of mineral analysis of "udara" samples is presented in Table 3a and 3b.

The mineral content of samples differed significantly ($p<0.05$) with blanching causing a reduction in the calcium (Ca), Zinc (Zn), sodium (Na), and iron (Fe) contents of the extract. Their contents in sample ranges as follows Na; 61.40-203.23 ppm and 63.75-281.44 ppm, Ca; 0.018-0.041% and 0.008-0.063%, Fe; 0.210-0.820% and0.330-1.030% and Zn; 8.400-42.120 mg/100gand 11.00-79.00 mg/100g for both peel and cotyledon respectively. The result of the mineral analysis of the extracts suggest that consumption of large quantities of "udara" or in combination with other dietary mineral sources is required to augment the recommended daily intake (RDI) of 2400mg for sodium, 100mg for calcium and 18mg for iron (Nestle, 2000). However, other researchers such as Mepba, *et al*., (2007) reported significant ($p<0.05$) reductions in K, Na, Ca, Zn and P contents of blanched fruits and vegetable.

The knowledge of RDI of minerals is important since sodium consumption of less than 2g per/day induces calcium loss in urine. Although low levels in these samples may contribute to their utilization in sodium restricted diets (0.22 – 1.07mg/100g), but high intakes may contribute to hypertension in some people (Wardlaw and Kessel, 2002). Ensminger *et al*. (1999) also reported that minerals in food are affected by heat and are mostly lost in cooking water. Human requirements for essential minerals vary from a few micrograms per day up to about 1g/day. If intakes are low for some period of time, deficiency signs will develop (Owen, 1996). Iron is an essential trace element for haemoglobin formation and in the oxidation of carbohydrates, protein and fats (Adeyeye and Ofokiti, 1999). The iron contents of all the extracts may help to augment in iron deficient cases, and serve as a catalyst in the form of

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Fe^{2+} and $Fe^{3+}$to catalyze lipid peroxidation in foods (Owen, 1996).

Calcium is also an essential nutrient of which its deficiency leads to osteoporosis in later life (Owen, 1996). Although its values in the products are quite low, it can combine with other food sources to make up 20 – 25% of the daily requirement of the body.The cells requires it and greater quantity (99%) of calcium in the body is used as structural components of bones and teeth which Wardlaw and Kessel (2002) reported that calcium represents about 40% of all the minerals present in the body.

Table 3a: Effects of blanching on the mineral contents of African star apple "udara" samples.

Minerals	Peel	A1	B1	C1
Na (ppm)	205.250±0.354b	75.620 ±0.570 c	68.530 ±0.396 e	61.400 ±0.071 g
Ca (%)	0.041± 0.001b	0.032± 0.003c	0.024± 0.001cd	0.018± 0.003d
Fe(%)	0.820± 0.283c	0.570± 0.028e	0.390± 0.028f	0.210± 0.042g
Zn(mg/100g)	42.120 ±0.028 b	35.000 ±0.566 d	17.000 ±0.028f	8.400± 0.566h

Values are means± SD (n=3). Mean values with the same superscript in a row are not significantly different (P>0.05). ND=Not detected.

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Table 3b: Effects of blanching on the mineral contents of African star apple "udara" samples.

Minerals	Seed	A2	B2	C2
Na (ppm)	281.440±0.570a	73.250 ±0.071 d	68.500 ±0.071 e	63.750± 0.042f
Ca (%)	0.065± 0.007a	0.024± 0.004cd	0.016± 0.003de	0.008±0.001e
Fe(%)	1.050± 0.028a	0.910± 0.028b	0.730± 0.028d	0.550±0.042e
Zn(mg/100g)	79.000 ±0.707 a	40.000 ±0.425 c	20.700 ±0.424 e	11.000± 0.283g

Values are means± SD (n=3). Mean values with the same superscript in a row are not significantly different (P>0.05). ND=Not detected.

Key

A_1- 2mins blanched extract of "udara" peel.
B_1- 4mins blanched extract of "udara" peel.
C_1- 6mins blanched extract of "udara" peel.
A_2- 2mins blanched extract of "udara" cotyledon.
B_2- 4mins blanched extract of "udara" cotyledon.
C_2- 6mins blanched extract of "udara" cotyledon.

Owen (1996) reported that besides structural role of calcium numerous biochemical and physiological processes (examples; in photosynthesis, oxidative phosphorylation, blood clothing, muscle contraction, cell division and nerve impulses. The zinc contents of the products upon consumption may help to alleviate zinc deficiency related cases. Zinc being an essential nutrient promotes good growth, improves skin appearance and appetite. However, its deficiency produces loss of appetite and retards growth.

CONCLUSIONS

Data obtained from this study on the vitamins, minerals and physico-chemical contents of African star apple's cotyledon and peel products indicates that food processing by blanching and pasteurization considerably reduces the quantities of these nutrients with increase in processing time from 2mins to 4mins and finally to 6mins when compared with those of raw/fresh samples.

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Author details:

Department of Food Science and Technology, University of Nigeria, Nsukka

Corresponding author: ikejon85@yahoo.com, okaforg@gmail.com and cokoyeuzu@yahoo.com,

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