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Full Length Research Paper

Nutrient composition and micronutrient potential of three wildly grown varieties of African star apple (*Chrysophyllum albidum*) from Nigeria

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Non-timber forest products are important for food security and they provide a significant nutritional contribution especially crucial during times of drought and famine, and create more varied, palatable, and balanced diets. Three varieties of African star apple (*Chrysophyllum albidum*) relished by both adults and youth when in season were analysed for their nutrient and antinutrient composition as potential source of micronutrients using standard methods of AOAC and spectrophotometric methods. The results showed that 100 g portion of fresh *Chrysophyllum albidum* varieties pulp contained between 73.2 and 76.3 g moisture, 3.9 and 4.1 g crude protein, 5.5 and 5.6 g crude fat, 4.1 and 4.5 g crude fibre, 2.2 g ash, 8.0 and 10.4 g carbohydrates, and yielded between 116.5 and 122.6 kcal of energy. The species were rich in micronutrients, containing between 666.21 and 700.81 mg potassium, 365.50 and 425.00 mg calcium, 211 and 228 mg phosphorus, 8.24 and 8.27 mg zinc, 86.80 and 99.63 mg ascorbic acid, 336.27 and 347.47 µg β-carotene; but very low in sodium (35.50 to 54.50 mg), iron (2.23 and 2.29 mg), phyatate (0.037 and 0.062 mg), oxalate (0.528 and 0.538 mg), tannins (1.345 and 1.560 mg) and trypsin inhibitors (3.165 and 5.095). *C. albidum* varieties were very high in micronutrients of nutritional importance, low in gross energy, sodium and antinutrients, and possess excellent values of index of nutritional quality, hence, their consumption by all people should be encouraged and promoted where and when the fruit is available.

Key words: Nutrient, antinutrient, micronutrients, *Chrysophyllum albidum*, nutritional quality.

INTRODUCTION

Non-timber forest products are important for food security, health, social and economic welfare of rural communities (FAO, 1989). They provide a significant nutritional contribution, especially crucial during times of drought and famine and create more varied, palatable, and balanced diets. A good knowledge of the potential of these fruit bearing species of trees and their capacity to contribute to food production will enhance the efforts to conserve forests or woodlands and make them more productive.

Foods obtained from trees and forests make an important direct contribution to people's food security needs, although the quantities involved may be small. Their nutritional contribution and value (especially micro-nutrients) are often critical especially at certain periods of the year, during droughts or other emergency periods when cultivated foods are unavailable. Few nutritional studies or projects mention forestry, and so few forestry activities focus on nutrition (Hoskins, 1985). This may probably be due to the fact that nutritionists concentrate on what are considered agricultural food rather than the bush berries and tiny reptiles, mammals or insects derived from the wild (Olapade and Kio, 1991; Ball et al., 1995).

However, there seems to be more awareness of the importance of the wild fruits consumed by the local

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people where the trees are indigenous as source of meeting nutritional needs of these people (Kuhnlein, 1989; Hernández-Pérez et al., 1994 and Melgarejo et al., 1995). *Chrysophyllum albidum*, a wildly grown plant in the Southwestern part of Nigeria belongs to the family of trees known as *Sapotaceae*. It is commonly known as "*Agbalumo*" or "*Osan*" (Yoruba) or "*Udala*" (Igbo) in the local languages. Its fruit which is pale yellow with pink coloured endocarp is relished by both children and adults when in season. Its fully ripe fruit becomes available from January through March in the Southwestern part of Nigeria. The pink-coloured pulp and the whitish cover of the brown-coloured seeds of the fruit are consumed, while the empty pale yellow pericarp is discarded.

In spite of the wide consumption of this wild fruit its contribution to nutrient intake of Nigerians has not been fully investigated. Edem et al. (1984) reported the proximate chemical, some selected minerals and vitamin composition of the fruit pulp and peel but no varietal differentiation on nutrient composition was mentioned. Literature information is scanty on the nutrient and antinutrient composition and contribution of this fruit pulp to nutrient intake of consumers. This study was therefore carried out to determine the nutrient and antinutrient composition and micronutrient potential of three wildly grown *C. albidum* varieties from Nigeria.

MATERIALS AND METHODS

Samples of fresh *C. albidum* varieties (*Chrysophyllum acreanum*, *Chrysophyllum africanum*, and *Chrysophyllum akusae*) were purchased from Bodija market in Ibadan and identified at Botany Department of University of Ibadan, Nigeria. Composite sample of each varieties was prepared by scraping the pulp of the fruit and its seed with spatula, blended thoroughly using a waring blender and labelled as samples A (*C. acreanum*), B (*C. africanum*), and C (*C. akusae*). Each of the samples was divided into two portions. One portion was used for moisture content and vitamin composition determinations, while the other sample was oven dried at 60°C for 18 h and used for other determinations. Chemical analyses were performed on each of the samples in triplicate as follows:

Proximate nutrient composition determination

Moisture content of the samples was determined by air oven method (Gallenkamp, Model OV – 440, England) at 105°C (AOAC, 1995). The crude protein of the samples was determined using micro-Kjeldahl method by digesting 5 g of the sample with conc. H_2SO_4 and Kjeldahl catalyst in Kjeldahl flask for 3 h. The digest was made up to 100 and 5 ml portion was then pipetted to Kjeldahl apparatus and 5 ml of 40% (w/v) NaOH solution added. The mixture was steam distilled, and the liberated ammonia collected in 10 ml of 2% boric acid, and titrated against 0.01 M HCl solution. The amount of crude protein was then calculated by multiplying percentage nitrogen in the digest by 6.25 (AOAC, 1995). Crude lipid was determined by weighing 5 g of dried sample into fat free extraction thimble and plugging lightly with cotton wool. The thimble was placed in the Soxhlet extractor fitted up with reflux condenser. The dried sample (at 60°C) was then extracted with petroleum ether and the crude lipid estimated as g/100 g dry weight of sample, and then converted to g/100 g fresh sample weight (AOAC, 1995). The ash content was determined by weighing 5 g of sample in triplicate and heated in a muffle furnace at 550°C for 4 h, cooled to about 100°C in the furnace and then transferred into a dessicator to cool to room temperature, weighed, and ash calculated as g/100 g original fresh sample. Crude fibre was determined using the method of Saura-Calixto et al. (1983). The carbohydrate content was obtained by difference. Gross energy of the samples was determined using ballistic bomb calorimeter (Manufacturer: Cal 2k – Eco, TUV Rheinland Quality Services (Pty) Ltd, South Africa).

Mineral analysis

Potassium and sodium content of the samples were determined by digesting the ash of the samples with perchloric acid and nitric acid, and then taking the readings on Jenway digital flame photometer/spectronic20 (Bonire et al., 1990). Phosphorus was determined by Vanado-molybdate colorimetric method (Ologhobo and Fetuga, 1983). Calcium, magnesium, iron, zinc, manganese, and copper were determined spectrophotometrically by using Buck 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk United Kingdom (Essien et al., 1992) and compared with absorption of standards of these minerals.

Vitamin analysis

Thiamine (Vitamin B_1) determination

Thiamine content of the fresh sample was determined by weighing 1 g of it into 100 ml volumetric flask and adding 50 ml of 0.1 M H_2SO_4 and boiled in a boiling water bath with frequent shaking for 30 min. Five millilitres of 2.5 M sodium acetate solution was added and flask set in cold water to cool contents below 50°C. The flask was stoppered and kept at 45-50°C for 2 h and thereafter made up to 100 ml mark. The mixture was filtered through a No. 42 Whatman filter paper, discarding the first 10 ml. Ten millilitres was pipetted from remaining filtrate into a 50 ml volumetric flask and 5 ml of acid potassium chloride solution was added with thorough shaking. Standard thiamine solutions were prepared and treated same way. The absorbance of the sample as well as that of the standards was read on a fluorescent UV Spectrophotometer (Cecil A20 Model) at a wavelength of 285 nm.

Riboflavin (Vitamin B_2) determination

One gram of each fresh sample was weighed into a 250 ml volumetric flask. 5 ml of 1 M HCl was added, followed by the addition of 5 ml of dichloroethene. The mixture was shaken and 90 ml of de-ionized water was added. The whole mixture was thoroughly shaken and was heated on a steam bath for 30 min to extract all the riboflavin. The mixture was then cooled and made up to volume with de-ionized water. It was then filtered, discarding the first 20 ml of the aliquot. 2 ml of the filtrate obtained was pipetted into another 250 ml volumetric flask and made up to mark with de-ionized water. Sample was read on the fluorescent spectro-photometer at a wavelength of 460 nm. Standard solutions of riboflavin were prepared and readings taken at 460 nm, and the sample riboflavin obtained through calculation.

Niacin (Vitamin B_3) determination

Five gram of blended fresh sample was extracted with 100 ml of distilled water and 5 ml of this solution was drawn into 100 ml volumetric flask and made up to mark with distilled water. Standard solutions of niacin were prepared and absorbance of sample and

Table 1. Proximate nutrient composition of *C. acreanum* (A), *C. africanum* (B) and *C. akusae* (C) (g/100 g).

Nutrient composition	A*	B*	C*	Mean**
Moisture	73.2 ± 0.02	74.7 ± 0.03	76.3 ± 0.01	74.7 ± 0.02
Protein	4.1 ± 0.01	4.0 ± 0.01	3.9 ± 0.01	4.0 ± 0.01
Fat	5.6 ± 0.04	5.5 ± 0.02	5.5 ± 0.01	5.5 ± 0.02
Crude fibre	4.5 ± 0.02	4.3 ± 0.01	4.1 ± 0.03	4.3 ± 0.02
Ash	2.2 ± 0.02	2.2 ± 0.02	2.2 ± 0.01	2.2 ± 0.02
Carbohydrates	10.4 ± 0.05	10.3 ± 0.04	8.0 ± 0.02	9.6 ± 0.04
Gross Energy (kcal/100 g)	122.6 ± 0.21	120.4 ± 0.21	116.5 ± 0.28	119.8 ± 0.23

*Results are the mean value of triplicate determinations for each of the *C. albidum* varieties, ** Result is the mean value for the three varieties of *C. albidum.*

standard solutions were measured at a wavelength of 385 nm on a spectrophotometer and niacin concentration of the sample estimated.

Ascorbic acid determination

Ascorbic acid in the fresh sample was determined by titrating its aqueous extract with solution of 2, 6-dichlorophenol-indophenol dye.

Tocopherol (Vitamin E) determination

One gram of sample was weighed into a 250 ml conical flask fitted with a reflux condenser wrapped in aluminium foil, and refluxed with 10 ml of absolute alcohol and 20 ml of 1 M alcoholic sulphuric acid for 45 min. The resultant solution was cooled for 5 min, followed by addition of 50 ml of distilled water and then transferred into a separating funnel covered with aluminium foils. The unsaponifiable matter in the mixture was extracted with 5 × 50 ml diethyl ethers. The combined extract was washed free of acid and dry oven anhydrous sodium sulphate. The extract was later evaporated at a low temperature and the residue obtained was immediately dissolved in 10 ml absolute alcohol. Aliquots of solutions of the sample and standard were transferred to a 20 ml volumetric flask, 5 ml absolute alcohol added, followed by a careful addition of 1 ml conc. HNO_3 and placed on a water bath at 90°C for exactly 30 min from the time the alcohol begins to boil. Rapid cooling under running water follows. The absorbance of sample solution was read at 470 nm.

Antinutrient analysis

Oxalate was determined by extraction of sample with water for about three hours and standard solutions of oxalic acid prepared and read on spectrophotometer (Spectronic20) at 420 nm. The absorbance of the fruit pulp extracts (with light pink milky colouration) were also read and amount of oxalate estimated. Phytate was determined by titration with ferric chloride solution (Sudarmadji and Markakis, 1977); while trypsin inhibitory activity was determined on casein and comparing the absorbance with that of trypsin standard solutions read at 280 nm (Makkar and Becker, 1996). The tannin content was determined by extracting the fruit pulps with a mixture of acetone and acetic acid for five hours, measured their absorbance and compared the absorbance of the extracts with the absorbance of standard solutions of tannic acid at 500 nm on spectronic20 (Griffiths and Jones, 1977). Saponin was also determined by comparing the absorbance of the fruit extracts with the standard at 380 nm (Makkar and Becker, 1996). The index of nutritional quality (INQ) of the fruit pulp, defined as the percent nutrient allowance divided by percent energy requirement was calculated as (Takruri and Dameh, 1998):

$$INQ = \frac{\%\ \text{of nutrient allowance}}{\%\ \text{of energy requirement}}$$

The nutritional quality of a foodstuff is rated as: INQ < 0.5 = poor, 0.5 – 0.89 = fair, 0.9 – 1.5 = adequate, 1.51 – 4.9 = good, and >5 = excellent.

Descriptive statistics and analysis of variance (ANOVA) were performed on the results obtained using SPSS version 15.0.

RESULTS

Table 1 shows the proximate nutrient composition of the three varieties of African star apple (*C. albidum*). The varieties were very high in moisture content. There was no significant difference ($p>0.05$) in moisture content of the three varieties, *C. akusae* (Sample C) having the highest value and *C. acreanum* (Sample A) the lowest. Also there was no significant difference in the crude protein, crude lipid, and ash content of the *C. albidum* varieties. *C. acreanum* (Sample A) had the highest value of crude protein, fat, fibre, carbohydrates and gross energy, while *C. akusae* (Sample C) had the lowest value. *C. akusae* (Sample C) had the lowest carbohydrate and gross energy content which was significantly different from the values for other two varieties.

There was significant differences in values of all the minerals studied among the three samples of *C. albidum* species ($p<0.05$), except for iron and zinc (Table 2). *C. africanum* (Sample B) had highest value of potassium and zinc while Sample C had highest value of all other elements. The species were high in potassium, calcium, magnesium, phosphorus, zinc, copper and manganese but low in sodium and iron.

The value of ascorbic acid (vitamin C) and α-tocopherol of *C. albidum* varieties were very high when compared with the recommended dietary allowances (RDA), their values exceeding the RDA of 75 and 90

Table 2. Mineral composition of *C. acreanum* (A), *C. africanum* (B) and *C. akusae* (C) (mg/100 g).

Mineral composition	A*	B*	C*	Mean**
Potassium	680.72 ± 2.82	700.81 ± 1.41	666.21 ± 2.12	682.58 ± 2.13
Sodium	35.50± 2.12	40.00 ± 1.41	54.50 ± 2.21	43.33 ± 2.05
Calcium	365.50± 2.12	382.50 ± 2.12	425.00 ± 2.41	391.00 ± 2.20
Magnesium	173.00± 1.24	177.50 ± 1.24	193.00 ± 2.12	181.17 ± 1.35
Iron	2.23 ± 0.04	2.24 ± 0.02	2.29 ± 0.02	2.25 ± 0.03
Phosphorus	216.50 ± 2.20	228.00 ± 2.24	211.00 ± 2.30	251.83 ± 2.25
Zinc	8.25 ± 0.04	8.27 ± 0.02	8.24 ± 0.03	8.32 ± 0.03
Manganese	4.85 ± 0.02	4.94 ± 0.04	5.16 ± 0.04	4.98 ± 0.35
Copper	5.63 ± 0.03	5.67 ± 0.03	5.82 ± 0.05	5.71 ± 0.35

*Results are the mean value of triplicate determinations for each of the *C. albidum* varieties, **Result is the mean value for the three varieties of *C. albidum*.

Table 3. Vitamin composition of *C. acreanum* (A), *C. africanum* (B) and *C. akusae* (C) (mg/100 g).

Vitamin composition	A*	B*	C*	Mean**
Thiamine	1.30 ±0.02	1.36 ±0.00	1.55 ± 0.02	1.40 ± 0.02
Riboflavin	0.80 ±0.02	0.85 ±0.01	0.97 ± 0.01	0.87 ± 0.01
Niacin	1.70 ± 0.14	1.25 ±0.21	1.56 ± 0.24	1.50 ± 0.21
Vitamin B_6	1.45 ± 0.28	1.57 ± 0.14	1.89 ± 0.28	1.64 ± 0.22
Ascorbic acid	86.80 ± 0.20	88.36 ± 0.21	99.63 ± 0.24	91.62 ± 0.21
β-Carotene (µg/100g)	336.27 ± 2.12	336.83 ± 2.24	347.47 ± 2.42	340.19 ± 2.20
α-Tocopherols (µg/100g)	19.04 ± 1.43	19.35 ± 1.48	18.17 ± 1.44	20.52 ± 1.45

*Results are the mean value of triplicate determinations for each of the *C. albidum* varieties, ** Result is the mean value for the three varieties of *C. albidum*.

mg/day of vitamin C for female and male respectively, and 15 mg/day of α-Tocopherol (Roth and Townsend, 2003; Rolfes et al., 2009), high in β-Carotene and relatively high in B-vitamins (Table 3). *C. acreanum* had the highest value of niacin, *C. africanum* was highest in α-Tocopherols, while *C. akusae* was highest in thiamine, riboflavin, vitamins B_6 and C as well as β-Carotene. Except for α-Tocopherol, there were significant differences in vitamin composition of the three species of *C. albidum* studied ($p<0.05$). There was no significant difference in values of β-Carotene for both *C. acreanum and C. africanum*, but their values were significantly different from that of C. *akusae*. The species of *C. albidum* studied were very low in antinutrients especially phytates and oxalates (Table 4). Trypsin inhibitors had highest value of antinutrients. The values of all antinutrients were significantly different from each other, with *C. akusae* (Sample C) having highest value of all antinutrients while *C. acreanum* (Sample A) had the lowest (Figures 1 to 3).

DISCUSSION

The three *C. albidum* varieties were very high in moisture content (Table 1). Their high moisture value is in agreement with the range of values reported in the literature for fruits and vegetables (FAO, 1968). Fresh fruits and vegetables are characterized by high moisture content as a mark of quality and extent of storage (Tressler et al., 1980). The moisture and crude protein content of the varieties were slightly lower than that of *Butyrospermum paradoxum*, a member of *Sapotacea* family as *C. albidum*, whereas the crude lipid, crude fibre, ash and carbohydrates content of *C. albidum* species were closely related to that of *B. paradoxum* (Adepoju and Ketiku, 2003). The pulp protein value was found to be low. However, this value was higher than the values obtained for mocan (1.5%), fluted pumpkin pod and pulp (1.4 and 1.3% respectively), and that of seven edible fruits of Bangladesh (2.0 to 7.5% on dry matter basis) (Hernández-Pérez et al., 1994; Essien et al., 1992; Nahar et al., 1990).

The crude lipid content of the varieties was low when compared with oil-rich seeds such as Sheabutter fruit kernel and soybean, and lower than the values reported by Edem et al. (1984) for the peel and pulp of *C. albidum* (12.4 and 15.1 g/100 g respectively) in the literature. However, these values were within the range reported for lipid composition of Sheabutter fruit pulp based on locality (Adepoju, 2012), and higher than that of fresh fluted pumpkin pod and pulp (0.50 and 0.30 g/100 g

Table 4. Antinutrient composition of *C. acreanum* (A), *C. africanum* (B) and *C. akusae* (C) (mg/100 g).

Antinutrient composition	A*	B*	C*	Mean**
Phytates	0.037 ± 0.01	0.043 ± 0.01	0.062 ± 0.02	0.047 ± 0.01
Oxalates	0.528 ± 0.02	0.536 ± 0.01	0.538 ± 0.02	0.534 ± 0.02
Tannins	1.345 ± 0.02	1.420 ± 0.02	1.560 ± 0.02	1.442 ± 0.02
Trypsin Inhibitors	3.165 ± 0.15	3.255 ± 0.15	5.095 ± 0.28	3.838 ± 0.20

*Results are the mean value of triplicate determinations for each of the *C. albidum* varieties, ** Result is the mean value for the three varieties of *C. albidum.*

Figure 1. *C. acreanum* variety (Sample A).

Figure 2. *C. africanum* variety (Sample B).

Figure 3. *C. akusae* variety (Sample C).

respectively), and wild berries in Bella Coola (0.50 to 5.6%), as well as that of Mocan fruit consumed by the Canary natives (Essien et al., 1992; Kuhnlein, 1989; Hernández-Pérez et al., 1994). The low level of lipid content of *C. albidum* may be responsible for the low value of gross energy of the fruit since 1 g of lipid yields more than twice the energy given by the same weight of either protein or carbohydrates.

The crude fibre content of the fruit was in close agreement with the value reported in the literature (4.0 g/100 g, Edem et al., 1984), and by far higher than that of fluted pumpkin pod and pulp (0.85 and 0.46 g/100 g respectively, Essien et al., 1992). The amount of crude fibre may influence the digestibility of the fruit and may also help to maintain the normal internal distention of the intestinal tract and thus aid peristaltic movements (Edem et al., 1984). The pulp may be a good source of dietary fibre, meeting part of the recommended dietary fibre requirement of between 15 and 20 g for prevention of nutritionally related diseases such as obesity, lowering of blood sugar and serum cholesterol, as well as cell growth and differentiation resulting into cancer (Kelsay et al., 1978; Sakata, 1993).

C. albidum was very low in carbohydrate content compared with mocan fruit which contains 45.8% available carbohydrates (Hernández-Pérez et al., 1994). However, its carbohydrate content is higher than that of the fresh pod and pulp of the fluted pumpkin fruit (5.6 and 4.84 g/100 g, Essien et al., 1992), and slightly higher than that of *B. paradoxum* (Adepoju and Ketiku, 2003). Its low carbohydrate content may be responsible for its lack of sugary taste. The gross energy contents of the varieties were slightly lower than the values reported for *B. paradoxum* (193.6 kcal/100 g, Adepoju and Ketiku, 2003). This might have been due to higher protein content of *B. paradoxum*. The low caloric value of the fruit pulp may be an advantage for its suitability for consumption as a snack by the obese.

C. albidum fruit pulp was very high in potassium, calcium, and phosphorus, zinc, manganese and copper (Table 2), higher than that of other fruit pulps such as *Spondias mombin, Dialium guineense* and *Mordii whytii*, but comparably lower in sodium and iron (Adepoju, 2009). The *Chrysophyllum albidum* varieties can be good source of potassium, calcium and phosphorus, which are needed for electrolyte balance, neurotransmission, development of strong bones and teeth (Roth and Townsend, 2003). The low sodium content of the fruit makes it suitable for consumption as snack by everybody including the hypertensive. Zinc is needed for proper growth and maintenance of cell integrity, and the level at which it is present is almost meeting the RDA of consumers. The fruit can also be source of micronutrients copper and manganese which are needed for proper enzymatic actions. The iron content of the fruit was low, and much of it has to be consumed before substantial amount can be obtained. Non haeme iron is less absorbed compared with haeme iron, but its absorption is enhanced by presence of vitamin C (Roth and Townsend, 2003).

Table 3 shows that *C. albidum* varieties were very high in ascorbic acid, β-Carotene and α-Tocopherol, moderate in thiamine, niacin and vitamin B_6 but low in riboflavin. The high ascorbic acid contenct of the fruit was believed

Table 5. Index of nutritional quality (INQ)* of *C. albidum* fruit pulp.

Nutrient	Mean nutrient content of fresh pulp/100 g	US RDA	% contribution to US RDA	% INQ
Gross Energy (Kcal)	119.3	2300	5.2	1
Protein (g)	4.0	65	6.2	1.2
Fibre (g)	4.3	20	21.5	4.1
Potassium (mg)	682.58	2000	34.1	6.6
Calcium (mg)	391.00	1000	39.1	7.5
Magnesium	181.17	420	43.1	8.3
Phosphorus (mg)	251.83	1000	25.2	4.8
Iron (mg)	2.25	18	12.5	2.4
Zinc (mg)	8.32	15	55.5	10.7
β-Carotene (µg) (RE)	340.19 (56.70)	1000	5.7	1.1
Riboflavin (mg)	0.87	1.7	51.2	9.8
Thiamine (mg)	1.40	1.2	116.7	22.4
Niacin (mg)	1.50	16	9.4	1.8
Ascorbic acid (mg)	91.62	65	141.0	27.1

RE = Retinol equivalent of vitamin A (1 µg RE = 6 µg β-Carotene), *Source: Takruri and Dameh (1998) and Roth and Townsend (2003).

to contribute greatly to the acidic taste of the fruit, especially when it is not fully ripe and soft. The β-carotene content of the fruit qualifies it as a good source of pro-vitamin A, and might be responsible at least in part for the pink colouration of the pulp of the fruit. Its high value of α-Tocopherol is an added advantage because of its antioxidant properties. The fruit's high content of ascorbic acid, β-carotene and α-Tocopherol (Vitamin E) which are strong antioxidants qualify it as a fruit with high health promoting potential. Antioxidants such as ascorbic acid, carotenoids and tocopherol, coupled with dietary fibre have been associated with prevention of nutritionally associated diseases such as cancers, diabetes, coronary heart disease and obesity (McDougall et al., 1996; Larrauri et al., 1996; Halliwell, 1997), and the pulp was high in these antioxidants and fibre. Low ascorbic acid levels have been associated with fatigue and increased severity of respiratory tract infections (Johnston et al., 1998), while high intake of vitamin C from food has been shown to raise serum HDL cholesterol and lowers serum triglyceride concentration (Ness et al., 1996), hence, this fruit pose to be of high nutritional importance and health benefits.

The observed differences in varieties' nutrient composition underscore the need to provide information on their nutrient composition for possible inclusion in the food composition table for Nigeria, as there is promotion of dietary diversity and consumption of different varieties within the same group or cultivar of plant foods as a means of combating micronutrient malnutrition. Table 4 revealed that the fruit pulp was very low in antinutritional factors, and possibility of intoxication or malabsorption of nutrients from other sources when large quantity of the fruit is consumed is very much unlikely. Trypsin inhibitors had the highest value among the antinutrients studied. There were significant differences in the phytate, trypsin inhibitors and tannin content of the fruits, *C. akusae* (Sample C) having the highest values, while *C. acreanum* (Sample A) had the lowest. However, there was no significant difference in the oxalate content of the three varieties of *C. albidum.* All the fruit pulp nutrient content had index of nutritional quality (INQ) values above 1.0, hence the fruit pulp was considered to be very nutritious (Takruri and Dameh, 1998), and its consumption should be encouraged (Table 5).

Conclusion

C. albidum varieties studied were high in micronutrient content, low in gross energy and antinutrients, hence they can be good snack or fruit for consumption for all. Its low carbohydrate content underscore its low value of simple sugar, hence it can be consumed by diabetic patients. Its low calorie, sugar, and high vitamin content qualify the fruit as suitable for the obese, while it's very low sodium content qualifies it as good fruit for the hypertensive. Its high value of INQ makes its consumption as fruit suitable for all. The fruit is also believed to be a good source of antioxidants (β-carotene, ascorbic acid and α-Tocopherol) needed by the body to prevent or combat the activities of free radicals. Its high ascorbic acid content however can be a limitation for its consumption by people with peptic ulcer.

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