NUTRITIONAL AND PHYTOCHEMICAL CONSTITUENTS OF THE AFRICAN STAR APPLE (*CHRYSOPHYLLUM ALBIDUM* G. DON)

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Abstract
In Ghana the C. albidum fruits are widely found growing in the forest and riverine areas. The fruits were bought from a local market in Accra, Ghana and were washed thoroughly to remove presupposed dirt. The pulp and the peel were separated and stored for subsequent analysis. The proximate, phytochemical and mineral constituent were determined using standard analytical methods. The moisture content of the pulp and peel were 72.0% and 58.5%, lactic acid was 0.88% and 2.9% for peel and pulp, acetic acid was 0.59 and 1.9 for peel and pulp respectively. Total solids was 41.5% and 28.0% for peel and pulp, total soluble solids was also 5.8 ^{0}Brix and 11.2 ^{0}Brix for peel and pulp. The pH value was 3.7 for peel and 3.0 for pulp, Carbohydrate was 34.6% and 60.1% for peel and pulp, protein also was 3.8 and 4.1% for peel and pulp respectively. Total starch obtained was 33.6% and 44.8% for peel and pulp. Vitamin C had peel value of 2.6 mg/100ml and the pulp 4.8 mg/100ml, total phenolic content was 68.3 µg GAE/g DW and 27.0 µg GAE/g DW for peel and pulp, total flavonoid was 3.71 mg GAE/g DW and 0.1 mg GAE/g DW for peel and pulp respectively and DPPH radical scavenging activity was also 49.3% and 26.0 % for peel and pulp respectively. The mineral compositions in the fruit were higher in the peel than in the pulp except for potassium which was vice versa and sodium which had equal amounts.

Keywords: *Chrysophyllum albidum*, proximate, phytochemical, elemental

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1.INTRODUCTION

The African Star Apple (*Chrysophyllum albidum*) from the family sapotaceae, is commonly found in the Central, Eastern and Western Africa (Adebayo *et a*l., 2010a; Amusa *et al*., 2003). They are distributed in Nigeria, Uganda, Niger, Cameroun and Cote d' Ivoire (Adebayo *et al*., 2010a). In Ghana the *C. albidum* are widely found growing in the forest and riverine areas. These include some parts of the Eastern Region that is the Akuapim North and South Districts, Suhum Kraboa – Coaltar District, some parts of the Central Region that is Mankessim; Western, Brong-Ahafo and Ashanti regions. The fruit is locally called Alasa in Ga language and Adaswa in the Akan language. *C. albidum* is a lowland rain forest tree species which can reach 25 to 37 m in height at maturity with a girth varying from 1.5 to 2 m (Orwa *et al*., 2009). The fleshy pulp of the fruits is widely eaten by the local populations. The pulp can taste either very sweet or sour. Locally, the variation of the fruit exocarp color is said to be correlated with the pulp taste. The exocarp of the sweet fruits are yellow while that of the sour ones have a mixture of yellow and green colours when matured. Previous studies on *C. albidum* in western Africa reported the importance of the species for local community livelihood improvement and its potentiality for the food industries. For instance, the physical, chemical and nutritional characterization of *C. albidum* fruits have shown a high industrial potential (Oyelade *et al*., 2005). Some ethno-botanical studies on the species have mentioned *C. albidum* used by local communities for medicinal and food purposes (Odugbemi *et al*., 2007). The cotyledons from the seeds of *C. albidum* are used as ointments in the treatment of vaginal and dermatological infections in Western Nigeria. The fruit pulp is rich in vitamin C and iron and an excellent source of raw material for industries (Akubugwo and Ugbogu, 2007). Tannins, flavonoids,

terpenoids, proteins, carbohydates and resins are the phytochemicals that have been reported in *C. albidum* (Akaneme, 2008). In Ghana not much research has been done on the fruit and the fruit is also underutilized. The study, therefore, was aimed at analyzing the physicochemical, phytochemical and elemental properties of *C. albidum* fruit.

2. MATERIAL AND METHODS

2.1 Sample Collection and Preparation

The *Chrysophyllum albidum* fruits were obtained from a local market in Accra, Ghana and were washed thoroughly to remove presupposed dirt. The fruits were opened to remove all the seeds and then the pulps were separated from the peels and stored prior to analysis.

2.2 Proximate analyses

2.2.1 Moisture content

Moisture content was determined according to the AOAC method (2000). Crucibles were cleaned and dried in an oven at 105 ^{o}C overnight, cooled to room temperature in a desiccator with dry Silica gel for 40min, and weighed to the nearest 1 mg (W0). A 2-3 g of the samples were weighed into the cooled crucibles (W1). The crucibles and samples were dried for 24 hrs at 105 ^{o}C, and the containers with the dried samples were cooled down in a desiccator with dry Silica gel for 1 hr and weighed to the nearest 1 mg (W2) immediately after removal from the desiccator. The moisture content in percentage (% MC) of the samples (average results of three replicates) was calculated.

2.2.2 Protein Content

The sample (0.2 g) was weighed into a micro-kjeldahl flask; 5ml of concentrated H_2SO_4 and one Kjeldahl catalyst tablet was added. The samples were digested in a fume cupboard for some few hours after which a clear colourless solution was left in the tube. The digest was transferred into 100 ml volumetric flask, thoroughly rinsing the digestion tube with distilled water; the volume of the solution made up to the mark with distilled water. A 5 ml of the digest was pipetted into the kjeldahl distillation apparatus and 5 ml of 40 % (w/v) of NaOH was added. The mixture was steam distilled and the liberated ammonia collected into a 50 ml conical flask containing 5 ml of 2 % boric acid plus methyl red indicator. The solution was titrated against 0.01 N of the HCl solution to the end point. The crude protein is determined by multiplying the percentage nitrogen by a constant factor of 6.25 (AOAC, 2000).

2.2.3 Total Carbohydrate

Anthrone reagent was prepared by dissolving 200 mg of anthrone in 100 mL of ice-cold 95 % H_2SO_4. Standard glucose: Stock was prepared by dissolving 100 mg of glucose in 100 mL of distilled water. A 2.5N HCl was prepared. Working standard was prepared by pipetting 10 mL of stock into a 100 ml volumetric flask and diluted to the 100 ml mark with distilled water. The working standard was stored in a refrigerator after adding a few drops of toluene. A 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard was pipetted in a test tube. Distilled water was added to make up the volume to 1 ml in all the tubes. A 4 ml of the anthrone reagent was then added. A 100 mg of the sample was weighed into a centrifuge tube. A 5 ml of 2.5 N HCl was added and kept in a boiling water bath for three hours, cooled to room temperature and neutralized with solid sodium carbonate until the effervescence ceased. The volume of the mixture was made up to 100 ml and centrifuged. 0.1 ml of the supernatant was pipetted for analysis. Distilled water was added to make up the volume to 1 mL in all the tubes containing the samples. A 4 ml of the anthrone reagent was added to each of the tubes and the samples were heated for eight minutes in a boiling water bath. The samples were rapidly cooled and the green to dark green colour was read at 630 nm. A standard curve was plotted. The absorbance of each of the solution was read and the amount of carbohydrate present in each of the sample tube was calculated (Hedge and Hofreiter, 1962).

2.2.4 pH Determination

A 10.0 g of the sample was weighed into a clean, dry Erlenmeyer flask and 100 ml freshly distilled water was added. The mixture shaken until particles was evenly suspended and free of lumps. The mixture was allowed to stand for 10min for particles to settle. The supernatant was decanted into a 250 ml beaker, and the pH was determined using pH meter (AOAC, 2000).

2.2.5 Vitamin C Content

Ascorbic Acid (Vitamin C) was determined by the Redox titration using Iodine solution. Vitamin C standard solution, iodine solution and 1 % starch indicators were prepared in accordance with AOAC (2000). A 10 drops of 1 % starch indicator was added to 25 ml of vitamin C standard solution in a 125 ml Erlenmeyer flask. Burette was filled with 0.005 mol/L iodine solution and initial volume recorded. The solution is titrated until the endpoint is reached and the final volume of iodine is recorded. Final vitamin C content was calculated from the relation: [0.005x176.12x Average Titre] mg/100 (AOAC, 2000).

2.2.6 Total Soluble Solids

The total soluble solids was determined using refractometer as per the procedure (Tigchelaar, 1986). One milliliter of the filtrate (juice) was applied on the refractometer and the readings taken from the scale directly as percentage.

2.2.7 Total Solids

The percentage total solid of each sample was determined using the equation:

Total Solids (%) = 100 – Moisture content.

2.2.8 Total Titratable Acidity

A 10 ml volume of extracted sample juice was measured and thoroughly mixed in 50 ml of distilled water. The mixture was titrated against 0.1 N NaOH with three drop of phenolphthalein until a pH of 8.1 (pink) was attained. The relative amount of Lactic acid and Acetic acid were determined (AOAC, 2000) using the mathematical formulae:

$$\text{Lactic Acid (\%)} = \frac{\text{Titre value X Normality X 9}}{\text{Volume of sample}}$$

$$\text{Acetic Acid (\%)} = \frac{\text{Titre value X Normality X 6}}{\text{Volume of sample}}$$

2.2.9 Estimation of Starch

The starch content was determined by weighing 0.5 g of the sample. The sample was treated with 80 % alcohol to remove the sugars. The starch is then extracted with 52 % perchloric acid. In hot acidic medium, starch is hydrolyzed to glucose and dehydrated to hydroxymethyl furfural. This compound forms a green colour with anthrone reagent which is read at 630 nm. A standard curve was plotted. The absorbance of each of the solution was read and the amount of carbohydrate present in each of the sample tube was calculated (Hedge and Hofreiter, 1962).

2.3 Methanol extractions for phytochemical analysis

The stored powdered samples were weighed (0.05 g) and extracted in 15 ml methanol at a temperature of 60 ^{o}C for 3 hrs and the supernatant recovered for further analyses.

2.3.1 Total phenolic content

The total phenolic contents were measured by the Folin–Ciocalteau method using Gallic Acid as standard. A 50 ml of the sample plus 3 ml of distilled water, 250 ml of Folin–Ciocalteau (fc 1/10) and 750 ml 20 % of Na_2CO_3. The mixture was vortexed to mix, incubated for 30 min in the dark and the absorbance measured at 760 nm (Singleton *et al*., 1999).

2.3.2 Total flavonoid content

The aluminium chloride colorimetric assay method (Zhishen *et al*., 1999) was employed for the total flavonoid content. Quercetin was used as standard. Total flavonoid content was determined as microgram (mg) Quercetin equivalent using the calibration linear regression equation. A 2800 ml distilled water, 1500 ml ethanol, 500 ml samples, 100 ml potassium acetate (1 M) and 100 ml of 10 % aluminium chloride were mixed and incubated in the dark for 30 min. The absorbance was read at 415 nm.

2.3.3 DPPH radical scavenging activity

The DPPH free radical scavenging activity was determined using 2, 2-diphenyl-1-picylhydrazyl (DPPH) free radical. A 200 ml of extracts was added to 3800 ml of 0.004 % DPPH in an ethanol solution. After 30 min of incubation at room temperature in the dark, the absorbance was measured at 517 nm. Radical scavenging was calculated as follows; 1 % = $[(Abs_0 - Abs_1)/Abs_0]$, where Abs_0 was the absorbance of 0.004 % DPPH without analyte and Abs_1 the absorbance of 0.004 % DPPH plus the test compound.

2.4 Elemental compositions

2.4.1 Elemental analysis using atomic absorption spectrophotometry (AAS)

The powdered sample was weighed (0.5 g) into a labelled 100 ml polytetrafluoroethylene Teflon bombs. 6 ml of conc. HNO_3 (65 %) and 1 ml of H_2O_2 (30 %) was added to the samples in a fume chamber. The samples were then loaded on a microwave carousel. The vessel caps were secured tightly. The complete assembly was microwave-irradiated for 20 min in a milestone microwave laboratory station (ETHOS 900 D model) using the following parameters; 2 min for 250W, 2 min for 0W, 6 min for 250W, 5 min for 400W, 5 min for 600W with a pressure of 100 psi, and temperatures of 400 ^{0}C and 500 ^{0}C. Five minutes was allowed for venting (Milestone Cook Book, 1996). After digestion, the Teflon bombs mounted on the microwave carousel were cooled in a water bath to reduce internal pressure and allow volatilized materials to resolubilize. The digest was made up to 20 ml with distilled water and assayed for the presence of iron, zinc, manganese, cadmium, magnesium, chromium, and lead in an acetylene-air flame. Reference standards for the elements of interest, blanks and repeats of the samples were digested the same way as the actual samples. These served as internal positive controls. The digested samples were then aspirated using Varian AA240FS fast sequential Atomic Absorption Spectrophotometer. The instrument was initially calibrated before the reading of any element with a standard solution of the element. A linearity of the calibration curve was always checked before the samples were aspirated. Calculation was obtained as stated below:

Final concentration (mg/kg) =

$$\frac{\text{Concentration X Nominal volume}}{\text{Weight of sample in grams}}$$

Concentration recorded = given on the monitor attached to the instrument

Nominal volume = final volume after reagent and water were added

Weight of sample = 0.5g.

2.4.2 Determination of Na^+ and K^+ using Flame photometer

Sodium and Potassium was determine by weighing 5g of the sample was weighed and leached in 100 ml of distilled water for 3 hours at 630 RPM. The solution was then filtered to get a clear solution. A 5ml of the supernatant was measured and 2 ml of Lithium standard solution (100 PPM) which act as Ionization Suppressor was added to it and homogenized. It was then aspirated into the flame photometer (Sherwood, Model 420) and the concentrations of Na and K read directly.

2.5 Statistical analysis

Statgraphics centurion (version 16) statistical tool was used for the analysis of variance and mean separations. Values were represented as mean ± S.D of triplicate data.

3. RESULTS AND DISCUTION

3.1 Physicochemical properties

There were significant differences ($p \leq 0.05$) in all of the physicochemical properties of the fruit's peel and the pulp with the exception of the protein content that showed no significant difference (Tables 1). The total titratable acidity (TTA) was calculated as percentage lactic acid and acetic acid. The pulp had higher values than the peel, this makes the taste of the pulp a bit astringent than the peel.

The pulp had the highest moisture content which was obtained to be 72.0 % (Table 1). Ureigho and Ekeke (2010) also reported a moisture content ranging from 70 % to 75 % for *C. albidum*. The moisture values obtained were higher than the moisture values reported by Amusa *et al*., (2003). Chukwumalume *et al*., (2010) had reported 31.97 % moisture content for the pulp of *Chrysophyllum albidum*. Moisture contents have a great value in the preservation of food materials. Moisture content is one of the most important and most widely used parameter in food processing. Abiodun and Oladapo (2011) reported 53.5 % moisture for the peel which is as similar to the results obtained.

The peel had a higher total solid than the pulp (Table 1), this is due to the fact that the moisture content of the peel was less than that of the pulp. The total solid is a measure of the amount of material remaining after all the water has been evaporated.

Both the peel and the pulp were within the acceptable limits. Higher Brix is an indication of maturity of the fruit. The pulp had higher Brix than the peel because the sugars, pectin, carbohydrate got broken into the fruit making it sweeter than the peel, hence the higher value.

The pH values were within the acidic food range. Acidity contributes to both, taste and food safety as it hinders the spoilage of food by microorganisms. The significance of pH at acidic range in foods cannot be overemphasized. The maturity of the fruit increases the citric acid content of the fruit there by increasing the acidity.

The carbohydrate contents of the pulp showed inverse variation and the values were higher than that of the peels (Table 1). This trend was similar to reports made on some other fruits like breadfruits, cashew and orange (Edet *et al*., 1984). The values obtained were lower than those obtained by Ukana *et al*., (2012) for the pulp and peel. The major metabolic role of the carbohydrate in the diets is for energy production. The pulp had the highest protein value (Table 1). Ige and Gbadamosi (2007) reported pulp and peel protein contents which were higher than the results obtained from this work. On the contrary, Ukana *et al*., (2012) obtained crude protein contents of *C. albidum* been higher in the peel than the pulp. Starch is a complex carbohydrate and serves as a source of energy when consumed. Unripen fruits have high starch content but as they ripen, the starch content are reduced which means the glucose units are broken down into individual units making the fruit more sweet. The values obtained (Table 1) indicated that the fruits were not fully ripen hence the likelihood of a sour taste especially in the pulp than the peel.

Table 1: Physicochemical properties of *Chrysophyllum albidum*

Sample ID	Total Titratable Acidity		Moisture (%)	Total Solids (%)	Total Soluble Solids (^{0}Brix)	pH	Carbohydrate (%)	Protein (%)	Total Starch (%)	Vitamin C (mg/100ml)
	Lactic Acid (%)	Acetic Acid (%)								
Peel	0.88±0.01^a	0.59±0.01^a	58.5±3.2^a	41.5±3.2^b	5.8±0.03^a	3.7±0.01^b	34.6±0.69^a	3.8±0.51^a	33.6±0.81^a	2.6±0.07^a
Pulp	2.9±0.04^b	1.9±0.03^b	72.0±1.5^b	28.0±1.5^a	11.2±0.01^b	3.0±0.01^a	60.1±0.66^b	4.1±0.51^a	44.8±0.52^b	4.8±0.15^b
	LSD = 0.061	LSD = 0.04341	LSD = 5.68	LSD = 5.68	LSD = 0.04984	LSD = 0.01309	LSD =1.527	LSD = 1.152	LSD = 1.546	LSD = 0.2588

Means ± standard deviations in the same column with different superscripts are significantly different ($p \leq 0.05$).

Table 2: DPPH free radical scavenging ability, total phenolic and flavonoid potency of *Chrysophyllum albidum*

SAMPLE ID	Total Phenolics (µg GAE/g DW)	Total Flavonoids (mg GAE/g DW)	DPPH Scavenging activity (%)
Peel	68.3±0.57[b]	3.7±0.79[b]	49.3±0.75[b]
Pulp	27.0±0.04[a]	0.1±0.03[a]	26.0±4.25[a]
	Lsd = 0.91	Lsd = 1.267	Lsd = 6.918

Means ± standard deviations in the same column with different superscripts are significantly different ($p \leq 0.05$)

This was because the starches have not broken down into simpler molecular units. The pulp had the highest vitamin C value. Dauda (2013) reported a vitamin C content of 12 mg/100 g for juice from *C. albidum* and 10.60 mg/100 g for papaya. Taylor (1987) reported 47.6 mg/100 g for *C. albidum* pulp, 48 mg/100 g for papaya. According to Ige and Gbadamosi (2007) the vitamin C content of *C. albidum* was 49.4 mg/100 L, some exotic fruits such as grape fruit (56 mg/100 L) and pawpaw (53 mg/100 g) and higher than many others such as sweet orange (31 mg/100 g), mango (34.7 mg/100 g and tomato (27 mg/100 g). Having the highest vitamin C value of 4.8 mg/100 ml in this study was even lower than earlier reports made. This might be due to the maturity of the fruit. Vitamin C is a water-soluble vitamin and the results obtained were within the acceptable limit for consumers.

3.2 Free radical scavenging ability, total phenolic and flavonoid potency of Chrysophyllum albidum

The phytochemical analysis of the methanol extract of the peel and pulp of *C. albidum* fruit revealed the presence of free radical scavenging ability, total phenolic and flavonoid. The presence of these phytochemicals contribute to the free radical scavenging ability of the fruit. The free radical scavenging activity of the peel was the highest. The peel having a higher free radical scavenging value indicated a higher free radical scavenging ability or activity than the pulp. It has been hypothesized that bioactive components with antioxidant capacities present in foods may contribute to lower incidence of cardiovascular disease (Wang, Melnyk, Tsao, & Marcone, 2011). Successful determination of biologically active compounds from plant material is largely dependent on the type of solvent used in the extraction procedure (Stankovic *et al*., 2010). Free radicals have very important roles in various pathogenesis, inflammatory diseases and can result in necrosis of the liver (Kehrer, 1993).

The total flavonoid content was higher in the peel. The relatively lower flavonoid content observed indicates that the flavonoids are hydrophilic instead of hydrophobic since we only use methanol for the extraction. Flavonoids are potent water soluble super antioxidants and free radical scavengers which prevent oxidative cell damage, have strong anticancer activity and inhibit tumor growth. According to Okoli and Okere (2010) the flavonoid concentrations (mg/100 g) in *Chrysophyllum albidium* plant parts: leaf was 15.3, root was 15.15, and seed was 45.80, while stem is 14.30. These values were higher than the flavonoid concentration got from its fruit parts which is the pulp and the peel.

The peel had the highest total phenolic content. The presence of phenolic compounds in the plant parts indicates that *C. albidum* contain antimicrobial agents (Huang and Chung, 2003). Phenolic compounds are considered to be bacteriostatic and fungistatic (Okwu and Morah, 2007). These compounds caused swelling of hyphal tips, plasma seeping around hypae, leaking of plasma, cell wall distortion, abnormal branching or fusion of hypae and consequently wrinkling of hypae surface (Okwu and Morah, 2007).

3.3 Mineral Content of Chrysophyllum albidum

The mineral content analyzed showed significant difference in most of the elements but not all. In the pulp, Lead (Pb), Chromium (Cr) and Cadmium (Cd) were not detected at all.

Table 3: Mineral contents of *Chrysophylum albidum* fruit

Sample ID	Elements Analyzed (mg/kg)								
	Fe	Zn	Pb	Cr	Mn	Mg	Na	K	Cd
Peel	4.96±0.28[b]	6.6±0.28[b]	8.26±0.03	0.13±0.01	2.58±0.03[b]	53.18±1.06[b]	2210±14.10[a]	16910±14.14[a]	ND
Pulp	2.36±0.28[a]	5.0±0.28[a]	ND	ND	0.58±0.08[a]	38.65±0.74[a]	2210±14.10[a]	30105±7.07[b]	ND
	Lsd = 1.217	Lsd = 1.217	Lsd = 0.086	Lsd = 0.0215	Lsd = 0.2721	Lsd = 3.927	Lsd = 60.8487	Lsd = 48.105	ND
Detection Limit	0.0060	0.0010	0.0010	0.0010	0.0020	0.0003	0.01	0.01	ND

Means ± standard deviations in the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 4: Safe values for As, Cd, Cu, Zn and Hg in some medicinal plants by Codex Alimentarius Commission (1991).

Elements	Maximum allowable limits of elements in fruits and vegetables (mg/kg dry weight)
As	0.2
Cd	0.2
Cu	40
Zn	60
Hg	10

10* mg/kg represents FAO/WHO limits for Hg in spices

Cadmium also was not detected in the peel. The amount of minerals in food is of interest because of their essential nature and effects on human life (Oktem *et al.,* 2005). According to Vallee and Auld (1990) iron (Fe) aids in transport of oxygen in red blood cells and in muscles. Zinc is required for the optimum functioning of many enzymes involved in catalytic functions, maintenance of structural stability, and regulatory functions (Colak *et al*., 2005). Recent findings suggest that copper acts as an antioxidant by protecting the brain and the nervous system. The essential metals can also produce toxic effects when the metal intake is excessively high. The iron content of the fruit was low, and much of it has to be consumed before substantial amount can be obtained. Ukana *et al*. (2012) reported that *C. albidum* peel and pulp had iron contents of 37.330 and 40.110 mg/kg respectively which were higher than the results obtained in this study. Iron is an important constituent of succinate dehydrogenase as well as a part of the haeme of haemoglobin (Hb), myoglobin and the cytochromes.

Lead is the most recognized toxic environmental pollutant. Maximum permissible limits in fruits and leafy vegetables and herbal or medicinal products are 10 mg/kg and 0.3 mg/kg for Pb and Cd, respectively (World Health Organization, 2005).

The results obtained indicates that the value of Lead present was within the permissible limit but when accumulated can cause acute toxicity.

Magnesium is an active component of several enzyme systems in which thymine pyrophosphate is a cofactor (Murray *et al*., 2000). *C. albidum* peel had higher amount of magnesium as compared to the pulp. High intake of Manganese that is above 10 mg/kg which is the recommended dose by WHO/FAO (1984) is regarded as a neurotoxic substance and the sample content was within the limit.

Sodium had the same content in the peel and pulp, potassium had content higher in the pulp than the peel. Ukana *et al*. (2012) reported lower sodium contents in the peel and pulp compared to the results obtained from this work.

Sodium is the principle extracellular cation and is used for acid base balance and osmoregulation in inter modular fluid (Crook, 2006). The recommended daily allowance of sodium is 115-75000 mg/kg for infants, 324-975 mg/kg for children and 1100-3300 mg/kg for adults, (Crook, 2006). Hence the value obtained for the peel and pulp were within the standard values.

Table 5: Percentage recovery of the analyzed elements

ELEMENTS	PERCENTAGE RECOVERY
Fe	98.96%
Zn	84%
Cd	80.8%
Pb	99.94%
Cr	100.05%
Mn	100.05%
Mg	100.4%

The standard percentage recovery ranges from 77–120%. Anything below 77 % is not good and when it is above 120 %, it means there was a contamination in the digestion.

Ukana *et al*. (2012) also reported potassium contents of the peel and pulp which were lower than the results obtained. The results also had higher potassium content than that of *Acalypha wilkesiana, Chromolaena odorata,* and *Tridax procumbens* reported by Ikewuchi and Ikewuchi, (2009b).

Potassium is the principal cation in intracellular fluid and functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulse, muscle contraction particularly the cardiac muscle, and cell membrane function (Murray *et al*., 2000).

4. CONCLUSIONS

The study showed that the *Chrysophyllum albidum* fruit had higher physicochemical properties in the pulp than in the peel, but pH and total solids rather had values that were higher in the peel than the pulp. The total phenolic content, total flavonoid and DPPH scavenging activity were all exhibited and were higher in the peel than the pulp, this means when consuming the fruit, the peel should not be discarded but washed properly and be consumed.

Cadmium was not detected in both the peel and the pulp, lead (Pb) and Chromium were also not present in the pulp but in the peel. Generally, the peel had higher values than the pulp in terms of the phytochemicals and the mineral content.

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