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Proximate, mineral and anti-nutritional composition of the outer peel and seed coat of *Chrysophyllum albidum* (African Star Apple) obtained from Minna, Niger State, Nigeria

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Abstract
The proximate, mineral and anti-nutritional compositions of *Chrysophyllum albidum* seeds were carried out using standard analytical methods. The seeds were obtained from discards of plants and prepared for use by decocting, sun drying and grinding into powder. The result of the proximate analysis showed that both samples are good sources of carbohydrate and energy with the seed coat having higher percentage carbohydrate content 60.06±0.02 than the outer peel (34.71±0.02). Other notable values for proximate parameters were, moisture (44.65±0.02) for the outer peel and (23.28±0.02) for the seed coat and ash content with (3.23±0.03) and (2.17±0.01) for the outer peel and seed coat respectively. The investigation of the mineral content revealed that the outer peel contains higher K (62.50±0.02 mg/100g) and Fe (40.10±0.01mg/100g) than the seed coat with K (53.50±0.02 mg/100g) and Fe (40.14±0.01mg/100g). Both samples are good sources of the mineral involved in biological functions like pH balance, heart-beat regulation and bone development. The anti-nutrient compositions revealed the high presence of saponins and cyanide in relative amount. Both part of the *C. albidum* fruit possesses micro-nutrients of nutritional importance and can be further processed by food industries to meet diverse nutritional needs.

Keywords: Carbohydrate, decocting, energy, grinding, sun drying

Introduction

Plant seeds are a good source of food for animals as well as humans, since they contain nutrients necessary for plants growth, including many healthy fats such as omega fats. In fact, the majority of foods consumed by human beings are seed-based foods. Some of the edible seeds are cereals, legumes and nuts. Oil seeds are often pressed to proceed to produce rich oils-sun flower, flax seed, rapeseed, and sesame. Seeds are typically high in unsaturated fats and in moderation, are considered a healthy food, although not all seeds are edible (Wikipedia, 2011; Mathew *et al.,* 2014). *Chrysophyllum albidum* fruit is common in both urban and rural centers especially during the months of December–April. The fruits are not usually harvested from the trees, but allowed to ripen on the tree and left to drop naturally to the ground where they are picked, since the immature fruit contains unpalatable sticky latex. The fruit of African star apple has been found to have a very high content of ascorbic acid with 1000 to 3,300mg of ascorbic acid per 100g of edible fruit or about 100 times than that of oranges and 10 times than that of guava or cashew (Amusa *et al.,* 2003). This fruit belongs to the family of *Myrtaceae* and the order *Myrtales*. It has a solitary auxiliary four-part flower with a dense ring of white stamen around the edge of the receptacle. The plants are usually shrubs that grow as small trees. They have localized distribution along the coast. They are cultivated by planting the seeds from a matured fruit (Emmanuel and Francis, 2010).

Material and Methods

Chrysophyllum albidum seeds were obtained from the fruits bought from Kasuwan Gwari, Minna, Niger state. The fruits were washed and the seeds separated manually and dried for about 5 days in the sun at ambient temperature for easy removal of the shells from the seeds. After the shells were removed from the seeds, they were further sun dried and made into fine powder and stored in a polythene bag for further analysis.

Methods

Moisture content

2g of each sample were put into the crucible, dried in an oven (Leniscope, England) at 105^{0c}overnight. The dried samples were cooled in a desiccator for 30 minute and weighed. The percentage loss in weight was expressed as percentage moisture content (AOAC, 1999).

Ash content

2.00 g of each of the grounded samples were placed in each crucible and ashed in a muffle furnace (Lenton Furnaces, England) at 600^{0}C for 3 hours. The hot crucibles were cooled in a desiccator and weighted. The percentage residual weighed was expressed as ash content (AOAC, 1999).

Crude lipid content

2.00 g of each sample were used for determining crude lipid by extracting lipid from it for 5 hours with petroleum ether in a Soxhlet extractor.

Crude fibre content

2.00g of each sample were used for estimating crude fibre by acid and alkaline digestion methods with 20% H_2SO_4 and NaOH solution.

Carbohydrate determination

Available carbohydrate (%), = 100 – (protein (%) + Moisture (%) + Ash (%) + Fibre (%) + Fat (%)).

Metabolisable energy

The metabolisable energy was calculated in Kilojoules (kJ) by multiplying the crude fat, protein and carbohydrate values by Atwater factors of 37, 17 and 17 respectively.

Minerals analysis

Sodium and potassium were determined using Gallenkamp Flame analyzer, while calcium, magnesium, iron, manganese, zinc and copper were determined using Buch Model 205 Atomic Absorption Spectrophotometer. Phosphorus level was determined using the phosphovanadomolybdate colorimetric techniques on JENWAY 6100 Spectrophotometer (Pearson, 1976).

Anti-nutritional properties

Tannin, Flavonoid and cyanide contents were determined using the method of Day and Underwood, (1986). Saponin and Alkaloid content was determined by the method described by Wheeler and Ferrel (1971).

Results and Discussion

Table 1: Results of the Proximate composition (%) of the outer peel and seed coat of *Chrysophllum albidium*

Parameters	Outer peel	Seed coat
Moisture content	44.65±0.02	23.28±0.02
Ash content	3.23±0.03	2.17±0.01
Crude fibre	6.58±0.02	8.59±0.02
Crude protein	1.90±0.15	2.51±0.03
Fat (Lipid)	8.93±0.02	3.39±0.02
Carbohydrate	34.71±0.02	60.06±0.02
Calorific energy value	513.29±0.15	319.71±0.02

Values are means ±SD of three determinations.

Table 2: Results for Mineral contents of the outer peel and seed coat of *Chrysophllum albidium* (mg/100g)

Minerals	Outer peel	Seed coat
Sodium	49.00±0.02	40.10±0.03
Potassium	62.50±0.02	53.50±0.02
Phosphorus	47.80±0.02	23.20±0.02
Calcium	9.15±0.01	70.68±0.02
Magnesium	7.16±0.01	34.49±0.03
Copper	14.45±0.02	26.45±0.02
Iron	40.14±0.03	8.30±0.02
Maganese	22.95±0.03	18.38±0.03
Zinc	6.38±0.03	28.34±0.02

Values are means ±SD of three determinations.

Table 3: Results showing the quantitative level of anti-nutrients in the outer peel and seed coat of *Chrysophllum albidium* (mg/100g)

Parameters	outer peel	seed coat
Saponin	1.67±0.03	3.61±0.05
Tannin	0.31±0.02	0.75±0.03
Alkaloid	0.24±0.05	2.10±0.02
Flavoinoid	0.37±0.01	0.23±0.01
Cyanide	0.05±0.02	1.09±0.01

Values are means ±SD of three determinations.

Discussion

The results of the proximate compositions of the peel and seed pericarp of African star apple are shown in Table 1 above. The result shows that moisture was 44.65±0.02 and 23.28±0.02% for outer peel and seed coat respectively. The moisture content is high with outer peel than seed coat. The moisture content obtained in this work was lower than 5.50%recorded for *C. albidum* (Ochigbo and Paiko, 2011). This indicates that the seed cannot be stored over a long period of time with a minute microbial activity taking place. The respective values of ash content 3.23±0.03 and 2.17±0.01 % for outer peel and seed coat respectively. Similar ash content was recorded for cherry (2.00±0.00%) reported by Mathew *et al.* (2014). The high ash content values of the samples indicates that the high quantity of inorganic minerals were present. The fibre content of the samples were 6.58±0.02 and 8.59±0.02 % for outer peel and seed coat respectively. The fibre content was high with seed coat than outer peeled. These values were lower than orange seeds (11.0%) and red roselle (28.50 %) reported by Anwar *et al*., (2008). The physiological role of crude fibre in the body is to maintain an internal distention for proper peristaltic movement of the intestinal tract (Oduor *et al.*, 2008). Crude protein of the outer peel and seed coat were 1.90±0.15 and 2.51±0.03 % respectively. High protein values were recorded with seed coat than outer peel. These values were lower compared to the 21.50±0.13 % recorded for water melon seeds (Mathew *et al.*, 2014). The relatively low protein contents in this work shows that, the samples can be regarded as low source of protein hence they can be modified into protein concentrate feeds for livestock when blend with other protein source. The fat content of the outer peel and seed coat were 8.90±0.02 and 3.39±0.02 % respectively. These were lower compared to cherry seed (13.00±0.01%) reported by Mathew *et al.* (2014). However, they cannot be regarded as oil seeds as their fat content were below 10 %.From the results of proximate composition it was observed that, the sample with the highest crude protein, fat and moisture contents had the lowest carbohydrate; this was observed with outer peel (79.32±0.02 %) while seed coat (83.89±0.02 %) had the highest carbohydrate content. This study also shows that both samples had good caloric values and could be of high nutritional importance.

The mineral contents of the samples were as presented in Table 2 and these values showed that these samples contained appreciable amounts of iron, sodium, potassium, phosphorus, calcium, magnesium and zinc. The concentrations of iron in outer peel and seed coat were 40.14±0.03 and 8.30±0.02 mg/100g respectively. The values obtained from this study were greater than the 28.87±0.10 mg/100g reported for water melon except seed coat (Mathew *et al.*, 2014). This implies that, outer coat could serve as blood building foods and should be desired for human and animal feeds formulations. The phosphorus contents of the samples were 47.80±0.02 and 23.20±0.02 mg/100g for outer peel and seed coat respectively. These values were higher than 10.01±0.20 mg/100g obtained for Cherry seed reported by Mathew *et al.* (2014).Potassium plays an important role in the human body and sufficient amounts of it in the diet protect against heart disease, hypoglycaemia, diabetes, obesity and kidney dysfunction. Adequate intake of this mineral from the diets has been found to lower blood pressure by antagonizing the biological effects of sodium (Einhorn and Landsberg, 1988). The potassium contents of outer peel and seed coat were 62.50±0.02 and 53.50±0.02 mg/100g respectively. Te result shows high potassium content with outer peel while seed coat had the least. These values were higher than the 13.93±0.10 mg/100g reported for cherry seed by Mathew *et al.* (2014).Zinc contents obtained from the samples were 6.38±0.03 and 28.34±0.02 mg/100g for outer peel and seed coat respectively. The zinc contents of these samples were higher than the value reported for the citrus seeds 1.00-9.00 mg/100g though similar to outer peel (Brown *et al.,* 1993). Regular consumption of this seeds may assist in preventing the adverse effects of zinc deficiencies which results in retarded growth and delayed sexual menstruation because of its role in nucleic acid metabolism and protein synthesis (Barminas *et al.* 1998).The daily requirement of sodium for male and female between 9 and 50 years is 1500mg which has been recommended as an adequate intake while after the age of 59 years, 1300mg has been considered as adequate by U.S Food and Drug Administration (Carol, 2011). The Sodium concentration for outer peel and seed coat were 49.00±0.02 and 40.10±0.03 mg/100g respectively. The values obtained here is higher with outer peel than seed coat. Calcium is an essential mineral for bone development. The calcium contents of outer peel and seed coat were 9.15±0.01 and 70.68±0.02 mg/100g respectively. The high value was recorded for seed coat while outer peel had the lowest. Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system and regulates blood sugar levels (Saris *et al.*, 2000). The magnesium concentrations of outer peel and seed coat were 7.16±0.01 and 34.49±0.03mg/100g respectively. The seed coat had the highest content of magnesium while outer peel had the lowest. Dietary deficiency of magnesium which is linked with ischemic heart disease could be prevented by regular consumption of these samples in the indigenous diet. Copper stimulates the immune system to fight infections to repair injured tissues as well as to promote healing. Severe deficiency of copper in pregnant mothers increases the risk of health problems in their foetuses and infants (Stern, 2010). The copper contents of the samples were 14.45±0.02 and 26.45±0.02 mg/100g for outer peel and seed coat respectively. The copper content obtained in this work was high with seed coat while outer peel had lowest.

In general, the high mineral contents of these samples showed that they can be consumed along with other foods in order to provide the required essential minerals for man and his farm animals. Thus they could be used as foodstuffs for feeds formulation. The results of the levels of anti-nutritional contents of this plant seed were presented in Table 3. The saponin contents of 1.67±0.03 and 3.61±0.05 mg/100g were recorded for outer peel and seed coat respectively. The saponins content of seed coat was higher compared to outer peel. The values of Tannin contents of 0.31±0.02 and 0.75±0.03mg/100g were recorded for outer peel and seed coat respectively. These values were lower with outer peel than seed coat contents of Tannin. High level of cyanide in foods has been reported with cerebral damage and lethargy in man and his animals (Akyildiz *et al.*, 2010; Ekpo *et al*., 2010) although most levels of this substance are generally regarded to be highly toxic to animals. The cyanide contents of outer peel and seed coat were 0.05±0.02 and 1.09±0.01 mg/100g respectively. The outer peel should be more desirable than seed coat base on their anti-nutritional composition. The cyanide contents obtained in this work showed that their consumption could be safe as far as their cyanide contents were concerned. The values of Alkaloid contents of 0.24±0.05 and 2.10±0.02mg/100g were recorded for outer peel and seed coat respectively. These values were lower with outer peel than seed coat contents of Alkaloid.

Conclusion

From the present study, it is strongly recommended that the industrial production and commercialization of this waste seed is given adequate attention in other to supplement the conventional seed that produce minerals for the body consumption like groundnut, linseed and cornflower to provide more sources of edible and industrial oil. This will also reduced waste hence a useful tool for economic development since wealth will actually be produced from waste.

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