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Utilization of some fruit tree rinds as a natural source of dietary compounds

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Abstract
The rinds generated from fruits are usually known as waste, but are beneficial and can be utilized instead of discarding them. The study aims at utilizing some fruit tree rind as a natural source of dietary requirements. Phytochemical screening, proximate and minerals of the fruit rinds were determined using standard analytical procedures, while the fruit rinds to be examined are *Chrysophyllum albidum, Persea americana, Annona muricata and Treculia africana*. The Phytochemicals screened include; Alkaloids, tannin, saponin, flavonoid, terpenoids, cardio glycoside and phlobatannin. The proximate parameters examined include; moisture content, crude ash, crude fibre, crude fat and crude protein, while the minerals investigated includes both the macro and micro elements. Having considered all the variants, the fruit rinds examined are highly nutritive, it has good dietary compounds and contain some phyto-constituents, hence, the result suggest the incorporation of the peel into animal feed instead of discarding them.

Keywords: Fruits, rinds, phytochemical, proximate, minerals

1. Introduction
Intake of fruits has increased greatly because of its taste, health benefits and disease prevention due to the presence of minerals, vitamins, fibre and some bioactive compounds required by human the body for a good and healthy life [1-2]. However, the high intake of these fruits shows an increase in the volume of waste generated by the rinds and seeds of the fruits. The rinds and seeds of different fruits can be valuable source for chemicals. The rinds and seeds have higher nutrients contents than the pulp fruits but rinds are known to be highly perishable due to the large amount of water composition they have [3-4]. Different drying techniques such as air circulation oven [4] and freeze-drying can be applied in fruit peels to delay perishing.

Chrysophyllum albidum L. is a forest tree species that naturally have diverse eco-zones in Nigeria, Niger Republic and Uganda. It belongs to Sapotaceae family and it is commonly called African star apple [5]. The fruit is of great economic importance and report shows that jams can be obtained from the pulp of the fruit, also can be compared with raspberry and jellies and the seed has oil which is used for diverse purposes [6]. *Chrysophyllum albidum* is known as agbalumo in south-west and udara in south-east Nigeria. Its helps promote good health by acting against oxidative stress-related diseases like coronary heart disease, cancer and diabetics [7]. Research shows that the fruit pulp contains ascorbic acid in a significant amount [8], food flavour, iron, vitamins, fat, carbohydrates and mineral elements [9-10]. Rinds of the fruit have shown to be rich in fibre and minerals [11-12]. Not only the fruit is being chewed but different products can be derived from it such as several types of soft drinks, syrup, stewed fruit and marmalade [13].

Annona muricata L. (Soursop) is originated from tropical America and now widely cultivated in India. It belongs to the Annonaceae family from custard apple tree. Numerous traditional medicinal uses have been associated with it and also, have been known as nutritional medicinal supplement [14].

Treculia africana (Decne.) is also known as african breadfruit, it is a tree species in the genus Treculia, belonging to the moraceace family, a tropical african leguminous crop. It is raised in the humid South Eastern ecological zone of Nigeria and humid rain forest of Southeast Cameroon [15]. Local African breadfruit is known as Ukwa in Igbo language, it is an important food crop in Nigeria and it's an economical plant that is mainly treasured. Seeds of *T. africana* are cooked and eaten by the Igbos, Kalabaris, Efiks, Edos and Ika Igbos in delta state in particular and some southern part in Nigeria [16]. Fresh seeds contain 38.3% carbohydrate, 15.9%, fat and 17.7% crude protein. It contains minerals like potassium, copper, calcium etc. [17]

Persea americana (Will.) is a tree belonging to the family Lauraceae, a native of Central America. It is used as food, traditionally used in treating hypotensive, hypoglycemic, anti-viral, ulcer, cardiovascular diseases etc. [18-19] Avocados are generally known as an analgesic and also have anti-inflammatory properties [20]. The pulp of avocado are used for different dermatological formulation such as emulsions for dry skin treatment, protective agent against anti-ageing and ultraviolent radiation [21] and its peel contains significant amounts of minerals [22]. Different fruit tree has been widely studied in previous research mainly on fruits and leaves, but only little research was explored on fruit tree peels. Thus, this study was conducted to determine the utilization of some fruit tree rind as a natural source of the dietary compound.

2. Materials and methods

2.1 Fruits Collection

Matured fruits of C*hyrsophyllum albidum*, *Annona muricata*, *Treculia africana* and *Persea americana* were bought in the market, they were washed thoroughly with distilled water to remove dirt and was later air-dried. The fruits were peeled and the rinds were separated from the pulp.

2.2 Preparation of Extract

(50g) of the rinds was macerated with 200ml of ethanol for 20 min, the rind extracted was filtered through filter paper and the residue was discarded. The supernatant was concentrated by rotary evaporator. The peel extracted was stored in a container and ready for analysis.

2.3 Phytochemical Screening

The qualitative phytochemical investigation was performed on the powdered rind sample using standard analytical procedures as described by Boye *et al.,* [23] and Omoruyi *et al.,* [24]. The preliminary evaluation was done to detect the secondary metabolites present such as saponins, alkaloids, flavonoids, cardiac glycosides, tannins, Phlobatannin and terpenoids.

2.4 Proximate analysis

The rinds samples were conducted for proximate analysis; Moisture content (using hot air method) Crude Ash, Crude fibre, Fat and Crude protein were determined by Association of Official Analytical Chemist AOAC [25].

2.5 Mineral composition

For mineral composition, the method used was determined using (Association of Official Analytical Chemists AOAC, [26]. This procedure was carried out by digesting the Ash with concentrated hydrochloric acid, then transferred to a volumetric flask and 100ml was made before the mineral elements was determined by using absorption spectrophotometer.

2.6 Statistical analysis

Data collected were statistically analyzed using the Statistical Product for Service Solution (SPSS) version 21. They were expressed as means and standard deviation (SD).

3. Results

The result of the phytochemical screening of the fruit tree rinds was expressed in Table 1. *Chrysophyllum albidum* rind shows the presence of alkaloid, tannin, saponin, flavonoid, terpenoid and cardio glycoside. *Annona muricata* rind indicates that alkaloid, saponin and flavonoid were present. *Treculia africana and Persea americana* show the presence of alkaloid, tannin, saponin, flavonoid and cardio glycoside.

Table 1: Qualitative phytochemical screening of some fruit tree rinds

Parameters	*Chrysophyllum albidum*	*Annona muricata*	*Treculia africana*	*Persea americana*
Alkaloid	+	+	+	+
Tannin	+	-	+	+
Flavonoid	+	+	+	+
Saponin	+	+	-	+
Terpenoid	+	-	-	-
Cardio glycoside	+	-	-	+
Phlobatannin	-	-	-	-

The proximate composition carried out in Table 2 on the fruit tree rind (*C. albidum*, *A. muricata*, *T. africana and P. americana*) are moisture content, ash values, crude fibre, crude fat and crude protein. All these parameters were present in all the fruit rinds except for fat which was not detected in *C. albidum* rind. *P. americana* rind has the highest moisture content of 50.27mg/100g.

Table 2: Proximate results of some fruit tree rinds

Parameters	*Chrysophyllum albidum*	*Annona Muricata*	*Treculia africana*	*Persea americana*
Moisture Content	4.61±12.00 [a]	10.54±3.15 [b]	32.55±2.62 [c]	50.27±2.48 [d]
Crude Ash	5.30±20.00 [a]	76.22±4.09 [b]	11.21±0.34 [c]	1.64±0.50 [d]
Crude fibre	7.0±16.10 [a]	9.72±5.78 [b]	3.26±1.25 [c]	36.1±2.02 [d]
Crude Fat	ND	1.20±0.04 [a]	4.71±0.09 [b]	3.20±1.25 [c]
Crude protein	2.90±21.01[a]	2.62±3.10 [a]	1.45±0.19 [b]	1.91±0.02 [b]

*Values are mean ± *SD* of triplicate determinations. Values with different superscripts in the same row are significantly different at $p < .05$

Table 3 shows the result of the mineral composition of the fruit tree rind. The values obtained for the macro nutrients from lowest to highest for *C. albidum* ranges from 24.10 - 254.22mg/100g, *A. muricata* ranges from 14.78-98.22mg/100g, *T. africana* ranges from 2.00-22.24mg/100g, *P. americana* ranges from 5.00-62.45mg/100g while the micro elements of the fruit rinds of *C. albidum* ranges from 0.98-3.37mg/100g, *A. muricata* ranges 0.04-2.65mg/100g. *T. africana* ranges from 0.28-1.42mg/100g and *P. americana* 0.06-0.91mg/100g.

Table 3: Mineral analysis of fruit tree rinds

Parameters (mg/100g)	*Chrysophyllum albidum*	*Annona muricata*	*Treculia africana*	*Persea americana*
Macro Elements				
Ca	125.14a ± 5.86 [a]	14.78±2.64 [b]	15.21 ±1.02 [b]	62.45±2.82 [c]
Na	24.10a ± 0.53 [a]	26.10±0.99 [b]	9.93 ±0.09 [c]	12.51±1.75 [d]
P	95.25a ± 3.96 [a]	17.93±2.44 [b]	22.24 ±0.98 [c]	20.00±2.16 [d]
K	254.22a ± 0.44 [a]	98.22±0.77 [b]	11.42±0.05 [c]	14.56±0.55 [d]
Mg	123.65a ± 1.12 [a]	31.54±1.52 [b]	2.00 ±0.07 [c]	5.00±1.50 [d]
Micro Elements				
Fe	3.37b ± 0.15 [a]	2.65±0.83 [b]	1.29 ±0.12 [c]	0.06±1.02 [d]
Zn	ND	1.34±0.51 [a]	1.29 ±0.26 [a]	0.45±0.03 [b]
Mn	1.25a ± 0.09 [a]	1.23±0.07 [a]	1.42 ±0.54 [b]	0.78±0.15 [c]
Cu	0.98a ± 0.03 [a]	0.56±0.34 [b]	0.45 ±0.02 [c]	0.91±1.26 [d]
Cr	ND	0.04±0.01 [a]	0.28±0.40 [b]	0.15±0.07 [c]

*Values are mean ± *SD* of triplicate determinations. Values with different superscripts in the same row are significantly different at $p < .05$.

4. Discussion

The fruit rinds investigated contains some phytochemicals, variable quantities of proximate and minerals. Phytochemicals possess bioactive compounds that help boost up immunolatory responses and provide strong immune system against different types of diseases. The result obtained in this study reveals the presence of some secondary metabolites in the four fruit tree rinds, which is in consonance with those reported by other authors. Phytochemicals like alkaloid, tannin, saponin, flavonoid, terpenoids, cardio-glycoside are all present. However, phlobatannin is absent in all the fruit rinds examined. In the findings of Ibrahim *et al.*, [27] who works on *Chrysophyllum albidum* peels, he reported the presence of majority of the phytochemicals studied in this research work except phlobatannin and cardiac glycoside that was absent. His research work compares favourably with my findings. Also the study undertaken by Narjis *et al.*, [28] on orange peels reveals similar result conducted in this study. The presence of alkaloid was also indicated across all the fruit rinds as expressed in table 1. A report by Njoya *et al.*, [29] shows the presence of alkaloid in *Citrullus lanatus* peels, which result also agrees with my findings. The implication of alkaloids in this rinds shows that they can acts as anti-inflammatory, anti-fibrogenic effect, antihypertensive, microbial effect, antifungal and anti-diarrheal effect Ghosal *et al.*, [30] The findings of Osarumwense *et al.*, [31] on *Citrus sinensis* peels report the absence of alkaloid which contradicts my research findings and shows the presence of flavonoid which agrees with my research study where all the plant rinds shows the presence of flavonoids. Also a research findings made by Karthikeyan and Vidya [32], for all the sample extract of *Pomegranate* peel shows the presence of flavonoid in all the peel extract. The presence of flavonoids in the rinds is an important source of natural antioxidants that are preferably compared to synthetic ones because they are less toxic. Flavonoid has antioxidant properties which are potent to defend the body from free radicals and oxygen species. They pose anti-inflammatory, anticancer and anti-allergic characters Ekam and Ebong [33]. Besides their role as a potent antioxidant, they also act as flavouring agent. Flavonoids have been reported to reduce the oxidation of low-density lipoprotein, lower the blood level of cholesterol and triglycerides. Tannin serves as antidote and has a wound healing property. It is also a very good antioxidant Norton [34]. Tannin has been found to be present in all the fruit rinds except *Annona muricata*, hence, the presence of tannin in all the plant rinds makes them a useful source of antidotes for poisons. Plants containing tannins are used for healing of wounds, varicose ulcers, haemorrhoids, frostbite and burns, hence, herbs containing tannins can be used as mouthwashes, eyewashes, snuff and even as vaginal douches and also treat rectal disorders. Flavonoid and tannin are present in the findings of Sulekha and Jaya [35], who worked on orange peel, but saponin was absent. Saponin is known for its foamy characteristics in a process called saponification. The pores in the cell membrane bilayers eg red cell (erythrocyte) are formed by complexation with cholesterol that is caused by saponin Rajput *et al.*, [36]. Saponin is absent only in *Treculia africana* rinds and present in other rinds conducted. Kaur *et al.*, [37] reported similar positive cases for saponin for different solvent extracts of orange peels except acetone that could not detect saponin. The presence of terpenoids was indicated only in *C. albidum* rinds and was absent in the rest fruit peels. Karthikeyan and Vidya [32], in their study reveals the presence of terpenoids in all the sample extract used in Pomegranate (*Punica granatum L.*) peels which is different from the result obtained in this study. Terpenoids, which presence inhibits cholesterol synthesis and also contains pharmacological activities such as anti-viral, anti-bacterial, anti-inflammatory and anti-malarial Mahato and Sen, [38]. Cardiac glycoside was found only in *C. albidum* and *P. americana*, while it was absent in *A. muricata* and *T. africana.* This is contrary to the research findings made by Olakunle *et al.*, [39] in the ethanolic extract of some fruit selected peels where cardiac glycoside was present in all the fruit peels evaluated. Also cardiac glycoside is present both in the ethanolic and aqueous extract of *Musa sapientum* peels in the findings of Ehiowemwenguan *et al.*, [40] which is contrary to the finding in this research. *C. glycoside* is very important in ethno medicine because of its mode of action that helps manage congestive heart failure Zhang *et al.*, [41]. They prevent the level of Na+/k+ pump that can results to the rising of sodium ions in the mycotes which can also lead to increase of calcium ions Desai [42], Phlobatanin was reportedly absent across the fruit rind, this compares favourably with the report of Ubaid *et al.*, [43]. Also, the findings of Olakunle *et al.*, [39] in ethanolic and aqueous extract of some selected fruit peels reveals total absence of phlobatannin across all the peels investigated which includes: orange, cashew, pineapple, banana. Daily diet has an important role in human health and healthy diet means getting enough of the essential nutrients needed daily by the body. After consuming fruits, the peel (rind) of these fruits are discarded, meanwhile, these peels have some nutritional and therapeutic properties. Studies show that the leaves, seeds and peels of fruits are very rich in some bioactive compounds Srividhya *et al.*, [44]. Proximate analysis result expressed in

Table 2 indicates that the peels of all the fruit rinds are rich in moisture, ash, crude fibre, fat and crude protein and were significantly different from each other. Moisture content result for Wasagu *et al.,* [45] for *Passiflora edulis* (Passion fruit) rind is 8.20% and Hanan and Abdelrahman [46], on watermelon rind is 10.61%, these results are higher than *C. albidum* which is 4.61% but lower to other fruit rind results gotten in this study. The Ash content (76.22%) in *A muricata* was the most abundant among the fruit rinds. The result gotten in this study for Ash value is higher than the result gotten by Edet *et al.,* [47] who worked on *Citrus paradis* peel which is (3.97%). The high ash content in the sample indicates the percentage of inorganic mineral elements present in the fruit rind. High mineral elements in foods enhance growth and development, and also catalyses metabolic processes in human body. Dietary fibre helps in lowering the level of cholesterol in our body and reduces the risk associated with cardiovascular disease caused by high plasma cholesterol level. It is believed that fibre usually reduces the amount of cholesterol in human blood and reduces the likelihood of different cancers. *P. americana* peel (rind) has the highest crude fibre of 36.1% in this study, while others have low quantities. Oluwole *et al.,* [48] result for crude fibre for *C. albidum* is 6.27%, Magda *et al.,* [49] for navel orange peels (13.38%) and mandarin peels (7.14%), this partially agrees with my finding for *C. albidum* which is 7.0% these results are higher compared to *T. africana* but navel orange value is higher than *A. muricata* (9.72%) in this study. Crude fibre contains indigestible cellulose which helps provide roughages, absorb water and also help the alimentary system to function properly. One of the major sources of energy is dietary fat, it guards internal tissues, adds to vital cell process and enhances the transportation of fat-soluble vitamins. It also assumed that excess of saturated fatty acids are responsible for a disease called coronary thrombosis and aortic atheroma in men and high level of polyunsaturated fatty acids helps lower cholesterol level in the blood Ibrahim *et al.,* [27] *T. africana* has the highest fat value of 4.71% compared to other fruit rinds. The crude fat was low as compared to the 13.01% obtained in the Congo mango Nzikou *et al.,* [50] The considerable value of fat in the rind is very vital and may provide the body with tremendous amount of energy. All the result gotten for the fruit rinds are all significantly different from each other except *C. albidum* and *A. muricata* which are not significant from each other in crude protein. Also, *T. africana* and *P. americana* were not significantly different from each other in crude protein. The rinds value reported for crude protein is lower compared to Oduntan *et al.,* [51] on *Irvingia wombolu* peel and Adepoju and Adeniji [8], on *C. acreanum*, *C. africanum*, and *C. akusae*. Minerals are greatly essential for maintaining good human health. The USA national institute of health (NIH) suggested that the recommended dietary allowance (RDA) for adult men and women from 19 to 70 years are: 1,000-1,200, 310-420, 4,700, 1,200-1,500, 0.9, 8-14, 1.8-2.3 and 8-11 mg *per* day of Ca, Mg, K, Na, Cu, Fe, Mn and Zn, respectively. Macro elements like calcium (Ca), sodium (Na), phosphorus (P) potassium (K), magnesium (Mg) are needed in major quantities in the body. The results of calcium, sodium, phosphorus, potassium and magnesium are presented in Table 3. Calcium helps in the formation of teeth, bones and also helps regulates blood, muscle and nerves functions. Calcium content was the highest in *Chrysophyllum albidum* rind (125.14mg/100g) followed by *Persea americana* rind 62.45mg/100g. The calcium content of key lime 51.0mg/100g and green grapefruit 30.0mg/100g peel in Anna *et al.,* [52] findings is lower than *C. albidum* and *P. americana* but it is higher than *A. muricata* and *T. africana.* Sodium (Na) value reported by *Damila et al.,* [53] findings for *Persea americana,* banana, watermelon and passion fruit is higher than the sodium results conducted for all the fruit rinds in this study. Also the level of sodium reported in Adeyeye [54], was 26.2mg/100g and it agrees favourably with the sodium gotten for *A. muricata* which is 26.1mg/100g while Adeyeye's result is higher than *C. albidum* which is 24.1mg/100g, *T. africana* which is 9.93mg/100g and *P. Americana* which is 12.51mg/100g but all the results gotten in my study for Zn are all lower than his findings for Zn. For enzymatic reactions, minerals generally act as co-factors. Sodium helps muscle nerve function, acts as a charge carrier and serves as a major factor in extracellular fluid Mgbemena [55]. *C. albidum* has the highest value for phosphorus 95.25mg/100g while *A. muricata* has the lowest value 17.93mg/100g. For a normal functioning of the kidney, ionic balance and transfer of nerve impulse in the body, phosphorus is highly required Ahmed and Chandhary [56]. The minerals analyzed were significantly higher ($p < .05$) in all the rind samples. The highest value for potassium was obtained in *C. albidum* 254.22mg/100g followed by *A. muricata* 98.22mg/100g, *Persea americana* 14.56mg/100g and the lowest value in *T. africana* 11.42mg/100g. Dietary Potassium (K) in fruit rinds helps suppress the blood pressure that can lead to stroke in human. However, some functions and protective effect of potassium goes beyond lowering of blood pressure. In carbohydrate and protein metabolism, magnesium serves as an enzyme activator Vormann [57], and it is present in all the fruit rinds conducted in this research in which *C. albidum* has the highest value. Damila *et al.,* [53] also reported 195.6mg/100g for melon peel on magnesium, this is higher compared to all the rinds conducted in this study. The micro elements such as Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu) and Cr conducted are all present in small quantities and these micro element plays important roles in metabolic activities. The results of (Fe) and (Zn) gotten by Edet *et al.,* [46] are comparatively higher than the results gotten in this study. However, all the values reported for microelements in this study are very low and are comparably similar to other results obtained by different authors.

5. Conclusion

The analytical information available from this study has shown that the rinds of *C. albidum, A. muricata, T. africana* and *P. americana* are good sources of fibre, protein, fat and energy. The nutritional compositions of the rinds evaluated are beneficial to human health. People may use rinds as a supplement in their diets after consuming the main fruit. It is considerably rich in iron needed for blood formation and transportation of oxygen and carbon dioxide between the tissues. All these suggest that these fruit rinds are good sources of food for human and animals. It can also serve as a natural source for dietary compound reducing the risk of chronic diseases and promoting physiological functions. The peels are quite nutritive and have much medicinal credence.

Conflict of interest

The author declares no conflict of interest.

References

1. Hossain MA, Rahman SMM. Total phenolics, flavonoids and antioxidant activity of tropical fruit pineapple. Food Res. Int. 2011;44:672-676.

http://dx.doi.org/10.1155/2013/472382.
http://www.bioline.org.br/pdf?ph05083
2. Ribeiro AB, Bonafé EG, Silva BC, Montanher PF, Santos Jr. OS, Boeing JS, *et al*. Antioxidant capacity, total phenolic content, fatty acids and correlation by principal component analysis of exotic and native fruits from Brazil. J. Braz. Chem. Soc. 2013; 24:797-804. Doi: 10.5935/0103-5053.20130105.
3. Moo-Huchin VM, Moo-Huchin MI, Estrada-León RJ, Cuevas-Glory L, Estrada Mota IA, Ortez-Vázquez E, *et al*. Food Chem And Utilization Of Breadfruit Seeds Artocarpus Altilis (Park) Fosb. (*Treculia africana* Decne) Family: Moraceae in Anambra state. Journal Research Agriculture 2015;4(1):27-30.
4. Santos LP, Morais DR, Souza NE, Cottica SM, Boroski M, Visentainer JV. Phenolic compounds and fatty acids in different parts of Vitis labrusca and V. vinfera grapes. J Food Res 2011;44:1414-1418.
5. Bada SO. Preliminary Information on the Ecology of *Chrysophyllum albidum* G. Don, in West and Central Africa. In: Proceedings of a National workshop on the potentials of the star apply in Nigeria. Denton 1997.
6. Amusa NA, Ashaye OA, Oladapo MO. Biodeterioration of African star apple (*Chrysphyllum albidum*) in storage and the effect on its food value. Afr J Biotechnol 2003;2:56-59.
7. Burits M, Bucar F. Antioxidant activity of Nigella sativa essential oil. Phytother Res 2000;14:323-328.
8. Adepoju O, Adeniji TPO. Nutrient composition and micronutrient potential of three wildly grown varieties of African star apple (*Chrysophyllum albidum*) from Nigeria. Afr J Food Sci 2012;6(12):344-351. DOI: 10.5897/AJFS12.045
9. Adisa SA, Vitamin C. Protein and mineral content of African apple (*Chrysophyllum albidum)* in proceedings of the 18th Annual Conference of NIST 2000, 141-146.
10. Ureigho UN. Nutrient Values of *Chrysophyllum albidum* Linn African Star Apple as a Domestic Income Plantation Species. Afr Res 2010;4:50-56.
11. IGE MM, Gbadamosi SO. Chemical Composition and Physical Properties of African Star Apple (*Chrysophyllum albidum*). ASSET Int J 2007;7:37-42.
12. Ukana DA, Aniekan EA, Godwin NE. Evaluation of proximate compositions and mineral elements in the star apple peel, pulp and seed. J Basic Appl Sci Res 2102;2:4839-4843.
13. Pandey M, Abidi AB, Singh S, Singh RP. Nutritional Evaluation of Leafy Vegetable Paratha. J Hum Ecol 2006;19:155-156.
14. Aditi Venkatesh Naik, Krishnan Sellappan. Physicochemical and Phytochemical Analysis of Different Plant Parts of *Annona muricata* L. (*Annonaceae*). Pharm Methods 2019;10(2):70-78.
15. Omobuwajo TO, Akande EA, Sanni LA. Selected Physical, Mechanical and Aerodynamic Properties of Africa Breadfruit (*Treculia africana*) Seeds. Journal of food Engineering 1999;40:241-244.
16. Okonkwo EU, Ubani ON. Indigenous Technologies for the Dehulling, Storage and Utilization of Breadfruit Seeds *Artocarpus Altilis* (Park) Fosb (*Treculia africana* Decne) Journal Research Agriculture 2007;4(1):27-30.
17. Oyetayo VO, Omenwa VC. Microbial and Chemical Qualities of Raw and Trona Processed African Breadfruit (*Treculia africana* Decne). American Journal of Food Technology 2006;1:77-80.
18. Anita BS, Okokon JE, Okon PA. Hypoglycemic activity of aqueous leaf extract of *Persea americana* Mill. Indian Journal Pharmacology 2005;37(5):325-326.
19. Kosińska A, Karamác M, Estrella I, Hernández T, Bartolomé B, Dykes GA. Phenolic compound profiles and antioxidant capacity of *Persea americana* Mill. Peels and seeds of two varieties. Journal Agricultural Food Chemistry 2012;60(18):4613-4619. http://dx.doi.org/10.1021/jf300090p
20. Adeyemi OO, Okpo SO, Ogunti OO. Analgesic and anti-inflammatory effects of the aqueous extract of leaves of *Persea americana* Mill. (Lauraceae). Fitoterapia 2002;73(5):375-380. http://dx.doi.org/10.3923/rjmp.2012.108.115
21. Korać RR, Khambholja KM. Potential of herbs in skin protection from ultraviolet radiation. Pharmacognosy Reviews 2011;5(10):164-173. http://dx.doi.org/10.4103/0973-7847.91114
22. Gondim JAM, Moura MFV, Dantas AS. Composição centesimal e de minerais em cascas de frutas. Ciência e Tecnologia de Alimentos 2005;25(4):825-827.
23. Boye AG, Koffuor GA, Boampong JN, Amoateng PA, Ameyaw EO, Ansah EO, *et al*. Gastroprotective effect and safety assessment of *Zanthoxylum zanthoxyloides* (Lam) Waterm root bark extract' American Journal of Pharmacy and Toxicology 2012;7(2):73-80.
24. Omoruyi BE, Bradley G, Afolayan AJ. Antioxidant and phytochemical properties of *Carpobrotus edulis* (L.) bolus leaf used for the management of common infections in HIV/AIDS patients in Eastern Cape Province, BMC Complementary and Alternative Medicine 2012;12;1-9.
25. AOAC. (Association of Official Analytical Chemists). *Official method of analysis* (20th edn). Washington, DC: Association of Official Analytical Chemist 2010.
26. AOAC. (Association of Official Analytical Chemists). *Official methods of analysis* (15th edn). Washington DC: Association of Official Analytical Chemist 1995.
27. Ibrahim HO, Osilesi O, Adebawo OO, Onajobi FD, Karigidi KO *et al*. Nutrients Compositions and Phytochemical Contents of Edible Parts of *Chrysophyllum albidum* Fruit. J Nutr Food Sci 2017;7(2):1-9. doi:10.4172/2155-9600.1000579
28. Narjis Hadi Mansoor, Najwa Shihab Ahmad, Shaima Ebraheem Sa'eed. Determination of some chemical compounds and the effect of oil extract from orange peel on some pathogens. Journal of Kerbala University 2009;7(2):33-39.
29. Njoya HK, Erifeta GO, Okwuonu CU, Elendu ZE. Estimation of some phytoconstituents in the aqueous extract of the endocarp, seeds and exocarp of *Citrullus lanatus* fruit. Journal of Pharmacognosy and Phytochemistry 2019; 8(3):4750-4757.
30. Ghosal S, Krishima Prasad BN, Lakshmi V. Antiamoebic activity of *piper longum* fruits against *Entamoeba histolytica in vitro* and *in vivo*. Journal of ethnopharmacology 1996;50:167-170.
31. Peter O, Osarumwense Lucky, Okunrobo O, Uwumarongie-Ilori EG. Phytochemical screening, proximate and elemental analysis of *citrus sinensis* peels (l.) Osbeck. J. Appl. Sci. Environ. Manage 2013;17(1):47-50.
32. Karthikeyan G, Vidya AK. Phytochemical analysis, antioxidant and antibacterial activity of Pomegranate peel. Research Journal of Life Sciences, Bioinformatics

Pharmaceutical and Chemical Sciences 2019;5(1):218-231. DOI: 10.26479/2019.0501.22
33. Ekam VS, Ebong PE. Serum protein and enzymes levels in rats following administration of antioxidant vitamins during caffeinated and non-caffeinated paracetamol induced hepatotoxicity. Nigeria. Journal of Physiology Science 2007;22:65-68.
34. Norton BW. The Significance of Tannin in Animal production. Tannin in Livestock and Human Nutrition. ACIAR Proceedings 2000;92:14-23.
35. Sulekha Gotmare, Jaya Gade. Orange Peel: A Potential Source of Phytochemical Compounds. International Journal of ChemTech Research 2018;11(2):240-243.
36. Rajput SS, Soni KK, Saxena RC. Pharmacology and phytochemistry of saponin isolated from *Aloe vera* for wound healing activity. Asian J Chem 2009;21:1029-1032.
37. Kaur M, Mehta A, Bhardwaj KK, Gupta R. Phytochemical analysis, antimicrobial and antioxidant activity assessment of orange peels. Journal of Global Biosciences 2019;8(3):6062-6072.
38. Mahato SB, Sen S. Advances in triterpenoid research, Phytochemistry 1997;44:1185-1236.
39. Olakunle OO, Joy BD, Irene OJ. Antifungal activity and phytochemical analysis of selected fruit peels. Journals of Biology and Medicine 2019;3(1):40-43. Doi: 10.17352/jbm.000013.
40. Ehiowemwenguan G, Emoghene AO, Inetianbor JE. Antibacterial and phytochemical analysis of Banana fruit peel. Journal of Pharmacy 2014;4(8):18-25.
41. Zhang D, Ciciriello F, Anjos SM, Carissimo A, Liao J, Carlile GW, *et al.* Ouabain mimics low temperature rescue of F508del-CFTR in cystic fibrosis epithelial cells. Frontiers in pharmacology 2012, 3-9.
42. Desai UR. The electrophysiological effects of cardiac glycosides in humans. Journal of Organisimic Biology 2000;56:16-19.
43. Ubaid Yaqoob, Irshad Ahmad Nawchoo, Mudasar Ahmad. Phytochemical Evaluation of Various Solvent Extracts of the Leaves, Fruits and Shoots of *Ferula Jaeschkeana* Vatke iMedPub Journals 2016;2:3-13. DOI: 10.21767/2472-0151.100019.
44. Srividhya M, Ramanatha K, Krishnanand N. Efficacy of citrus fruit peel extracts against pathogens causing gastrointestinal disorders. International Journal of Pharmacy and Pharmaceutical Sciences 2013;5(4):160-163.
45. Wasagu RSU, Lawal M, Amedu AM, Sabir AA, Kabir S, Tukur UG, *et al*. Comparative Chemical Analysis, Phytochemical Screening and Antimicrobial Activities of the Rinds, Seeds and Juice of (*Passiflora edulis* var. flavicarpa) Passion Fruit Journal of Natural Sciences Research 2016;6(19):138-143.
46. Hanan MA, Al-Sayed Abdelrahman, Ahmed R. Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. Annals of Agricultural Science 2013;58(1):82-95.
47. Edet UO, Ebana RUB, Ekanemesang UM, Ikon GM, Edem EE, Mbim EN. Phytochemical Screening, Nutrient Analysis, Antitermite and Antimicrobial Activity of *Citrus paradis* Peel Powder. Journal of Applied Life Sciences International 2016;9(4):1-9.
48. Oluwole Oluwatoyin Bolanle, Odediran Olajumoke, Ibidapo Olubunmi, Pheabean Owolabi, Samuel, Chuyang Li. Garry. Proximate Composition, Phytonutrients and Antioxidant Properties of Oven Dried and Vacuum Dried African Star Apple (*Chrysophyllum albidum*) Products. International Journal of Nutrition and Food Sciences 2017;6(1):22-25. http://www.sciencepublishinggroup.com/j/ijnfs doi: 10.11648/j.ijnfs.s.2017060601.14.
49. Magda RA, Awad AM, Selim KAS. Evaluation of mandarin and navel peels as natural sources of antioxidant in biscuit. Alex Journal of Food Science & Technology Speacil 2008, 75-82.
50. Nzikou JM, Kimbonguila A, Matos L, Loumouamou B, Pambou-Tobi NPG, Ndangui CB, *et al*. Extraction and Characteristics of Seed Kernel Oil from Mango (Mangifera indica). Research Journal of Environmental and Earth Sciences 2010;2(1):31-35.
51. Oduntan AO, Babalola SO, Kenneth-Obosi O, Awe OFE, Olabode LA, Egbekunle K, *et al*. Evaluation of Promixate, amino acid profile and oil characterization of *Irvingia wombolu* fruit pulp and peel. International food Research Journal 2019;26(4):1371-1377.
52. Anna Czech, Ewa Zarycka, Dmytro Yanovych, Zvenyslava Zasadna *et al*., Mineral Content of the Pulp and Peel of Various Citrus Fruit Cultivars Biological Trace Element Research 2020;193:555-563. https://doi.org/10.1007/s12011-019-01727-1
53. Damila Morais R, Eliza Rotta M, Sheisa Sargi C, Elton Bonafe G, Rúbia Suzuki M, Nilson Souza E, *et al*. Proximate Composition, Mineral Contents and Fatty Acid Composition of the Different Parts and Dried Peels of Tropical Fruits Cultivated in Brazil, J. Braz. Chem. Soc 2017;28(2):308-318. http://dx.doi.org/10.5935/0103-5053.20160178
54. Adeyeye IE. Proximate, mineral and anti-nutrient composition of Dika nuts (*Irvingia gabonensis*) kernel, Elixir Food Science 2013;58:14902-14906.
55. Mgbemena NM, Obodo GA, Anusiem ACI, Ezigbo CI, Ilechukwu I, Mgbo VO, *et al*. Fundamental aspects of chemistry, M. and J. Grand Orbit Communications Port Harcourt Nigeria 2016, 67-72.
56. Ahmed D, Chandhary MA. Medicinal and nutritional aspects of various trace metals determined in Ajugabracteosa. Journal of Applied Sciences Research 2009;5:864-869.
57. Vormann J. Magnesium: Nutrition and metabolism. Molecular Aspects of Medicine 2003;24:27-37. Available: https://doi.org/10.1016/S0098-2997(02)00089-4.