British Journal of Applied Science & Technology
16(5): 1-9, 2016, Article no.BJAST.22481
ISSN: 2231-0843, NLM ID: 101664541

SCIENCEDOMAIN *international*
www.sciencedomain.org

Mineral Composition of Ashed and Charred Palm (*Elaeis guineensis*) Bunch and Plantain (*Musa paradisiaca*) Peel

A. U. Israel[1] and I. A. Akpan[1*]

[1]*Department of Chemistry, Faculty of Science, University of Uyo, Uyo, Nigeria.*

Authors' contributions

This work was carried out in collaboration between both authors. Author IAA designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed literature searches. Authors AUI and IAA managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/22481
Editor(s):
(1) Sumit Goswami, Senior Scientist, Pfizer Inc., Chesterfield, MO, USA.
(2) Meng Ma, Anhui University, Hefei, Anhui, China and Icahn Institute for Genomics and Multiscale Biology, Icahn School of Medicine at Mount Sinai, New York, USA.
Reviewers:
(1) Anthony Cemaluk C. Egbuonu, Michael Okpara University of Agriculture Umudike, Nigeria.
(2) Anonymous, Jawaharlal Nehru Technological University, Anantapur, India.
(3) Volodymyr Chernyshenko, Palladin Institute of Biochemistry NAS of Ukraine, Ukraine.
Complete Peer review History: http://sciencedomain.org/review-history/15056

Original Research Article

Received 3rd October 2015
Accepted 13th June 2016
Published 17th June 2016

ABSTRACT

This study was carried out to determine the mineral composition, ash content, percentage volatile content (PVC) as well as the pH, total alkalinity and conductivity of the aqueous solution of the ashes of palm bunch and plantain peels respectively. The mineral contents of the ash (charred and ashed) of both palm bunch and plantain peels were determined using standard methods of the analyses of AOAC and atomic absorption spectrophotometric method. The ash content and percentage volatile content (PVC) were 12.50%, 4.70% and 75.0%, 54.20% for the palm bunch and plantain peel wastes respectively. The pH for the palm bunch and plantain peels waste ash solutions were 11.037±0.002, 11.040±0.013 and 9.905±0.001, 10.898±0.521 for ashed and charred samples respectively, while total alkalinity were 8997±3.830, 128,993±24.211 and 3993.25±8.995, 158,021.50±43.00 for the ashed and charred palm bunch and plantain peels solutions, respectively; indicating that the solutions were completely alkaline. The mineral elements and anions in the ashed sample of palm bunch were in (mg/l), K(932.588±1.107), Na(6249.75±1.708),

**Corresponding author: E-mail: iaakpanchem2007@yahoo.com;*

Ca(31.70±1.010), Mg(39.204±0.387), and the anions in (mg/l): chloride (2556.00±1.630), ammonium (1.468±0.015) nitrate (1.05±0.012), sulphate (48.355±0.104), phosphate (184.070±0.009) and nitrate (1.050±0.012) while in the charred sample (mg/l): K(1200.00±1.633), Na(499.000±2.582), Ca(146.500±1.291), Mg(117.945±0.725) and the anions (mg/l): chloride (241.500±1.291), ammonium (1.52±0.016), nitrate (2.008±0.095), sulphate (48.355±0.i04), phosphate (159.148±0.284). Similarly in the ashed plantain peel (mg/l): K(333.338±0.017), Na(270008.500±10.116), Ca(ND), mg(16,917.250±0.957) while the anions were (mg/l): chloride (9556.000±1.633) ammonium (2.150±0.006), nitrate (1.215±0.006), sulphate (30.475±0.010), phosphate (282.615±0.019). The mineral contents of the charred plantain peels were (mg/l): K(333.648±0.547), Na(3726.000±1.414), Ca(ND), Mg(0.336±0.040) and anions (mg/l): chloride (17047.500±9.574), ammonium (3.155±0.104), nitrate (2.85±0.006), sulphate (36.215±0.019) and phosphate (483.900±0.149) respectively. The conductivity of the solutions of both ashed and charred ashes of palm bunch were (ohms/cm) 40.388±0.104 and 32.723±0.186 while for the plantain peels were 54.783±0.302 and 27.17±0.008 respectively.

Keywords: Agricultural wastes; mineral composition; palm bunch; plantain peels; potash.

1. INTRODUCTION

Agricultural wastes have been known to contain mineral elements if ashed or charred [1]. Most plant ash derived from agricultural wastes such as palm bunch chaff, plantain peels, banana leaves, cocoa pods, maize cobs, sugar beet wastes and others contain a good percentage of potash and soda ash. When these materials are burnt in air the resulting ashes contain oxides of potassium, sodium, calcium which yield their corresponding hydroxides upon dissolution in water which of course are of great importance to soap making industries. There are many agricultural wastes materials generated from agricultural activities and are littered all over the environment. Some of these agricultural wastes like coco-pod have adverse effect on soil fertility and so constitute environmental nuisance to man.

However, research had indicated the viability of vegetable matters especially the agricultural wastes materials for alkali production [2,3]. So they are a potential viable source which needs to be harnessed for other uses and to save the environment. Materials such as plantain peels, cassava peels, palm bunch, wood and others yield a high potash content when combusted, charred or ashed. The local production of potash from these agricultural wastes has been found to be a cheaper alternative source of the much needed chemical used in the production of soap, fertilizer and other alkalis based products [4].

The African oil palm (*Elaeis guinensis*) is the most industrialized palm in the world, with extensive areas under plantation cultivation especially in Africa and South East Asia. In palm oil factories, after processing the entire ripe fruit, the empty bunches and unusable residues from oil extraction are used as fuel, locally. The palm bunch ash obtained from the discarded bunch is useful as suitable reinforcement of Portland cement [5]. By itself, palm bunch ash is an effective NPK fertilizer in maize growth [6].

Palm ash is the scouring agent in some recipes for the African black soap. In fact, palm bunch ash is a commercial product exported from Indonesia [7]. Recently, Akunna et al. [1] had reported the production of black soap using the ash from palm bunch.

Also, plantain peels are the wastes generated from plantain processing. These wastes are dumped in landfills or indiscriminately littered in the environment [8]. The peel of the fruit is discarded as waste after the inner fleshy portion has been eaten, thereby constituting a menace to the environment especially where its consumption is high. The leaves, pseudostem, fruit stalks, bracts and peels have been considered for use as organic fertilizer in Somalia and Malaya [9]. Various parts of the plant such as leaves, roots, fruit stalks and bract have been used for medicinal and domestic purposes.

The leaf juice is used in the treatment of fresh wounds cuts and insect bites while the leaves act as an arbortifacient. Its sap is used as a remedy for diarrhea, dysentery, hysteria and epilepsy. The fruit has been reported to be used as antiscorbutic, aphrodisiac and diuretic [10]. Adeniyi et al. [11] reported 100 g edible portion of plantain to contain 67.30 g moisture, 0.4 g crude fat, 31.15 g carbohydrate, 0.95 mg potassium, 35.10 mg sodium, 71.5 mg calcium, 28 mg phosphorus, 2.4 mg iron and yielded 116 kCal of energy.

Presently, the Federal Government of Nigeria policy on sourcing for local raw materials which are non-toxic and potentially suitable for alkali generation has given rise to an increase interest in research efforts geared towards exploiting locally available vegetable materials. Palm bunch is a byproduct of the palm oil processing industries.

The current study focuses attention on the determination of the mineral composition of these agricultural wastes especially in the production of potash and soda ash which are potential raw materials as the soap manufacturing industries, fertilizer production and reinforcement agent in the production of portland cement.

2. MATERIALS AND METHODS

Palm bunch were collected from local oil palm from Abak in Akwa Ibom State, Nigeria. The plantain peels (ripe/unripe) were collected from road side traders in Uyo, Nigeria. The samples were thoroughly washed with distilled water, sundried for 168 hrs and then oven dried at 100ºC to constant weight. The samples were ground into fine powder and stored in polyethene containers until when needed for analysis.

2.1 Chemicals and Reagents

All the chemicals and reagents used in this study were of analytical grade and were products of British drug House (BDH) laboratory, England.

2.2 Ashing of Samples

Ground palm bunch (20 g) was weighed into a crucible which was heated to red hot. The contents of the crucible were agitated occasionally to bring fresh particles to the interface so as to ensure complete ashing and combustion. The ashing lasted for 6 hrs at the ashing temperature of 550ºC. The ashed product was reweighed. The same treatment for the palm bunch above was applied to the ground plantain peels for ashing treatment.

2.3 Charring of Samples

In the charring procedure, palm bunch (20 g) were placed in a crucible and fire was put on it directly to ensure complete combustion [1]. Similar treatment was given to 20 g of ground plantain peels. Both the ashed and charred products were stored separately in air tight lid containers until when needed.

2.4 Extraction of Ashes

Palm bunch ash: The palm bunch ash (10 g) was dissolved with distilled water (50 ml) in the portions of 10 ml each in different test tubes for proper dissolution. The combined solutions were filtered and the filtrate made up to 100 cm^3 with distilled water. The pH of the extract was determined and recorded.

2.5 Mineral Element Analysis

Potassium and sodium were determined using the digested extracts of the samples and taking readings on Jenway Digital Flame Analyser PFP7. Calcium, magnesium, iron, manganese, copper, lead, nickel, cobalt, zinc, cadmium, chromium were determined spectrophotometrically by using Buck 200 atomic absorption spectrophotometer and their absorption compared with absorption of standards of these metals.

Phosphorus was determined by the vanado-molybdate colorimetric method using UV/visible spectrometer UNICAM 8700. Chloride content was determined using the AOAC (1984) method. This was carried out by titrating the extract from the ash samples (10 ml) against standard $AgNO_3$ (0.163M) using 10% K_2CrO_4 as indicator.

Nitrate was determined using the Brucine colorimetric method. In this method, 10 ml of the extract was pippetted into 25 ml conical flask and 2 ml of brucine was added followed by conc. H_2SO_4 (10 ml). The content of the flask was allowed to mix for 15 mins. The solutions were then made up to the mark and the absorbance taken, and the quantity of nitrate determined.

Sulphate in the extracts was determined using the Gelatine-$BaCl_2$ reagent method. Gelatine (0.6 g) was added to hot water (200 ml) and allowed to cool in a refrigerator for 16 hrs. Baruim chloride decahydrate (2.0 g) was allowed to dissolve in this solution and allowed to stand for 2 hours at 30ºC. Then the extract (1 ml) was taken in standard flask (10 ml) and gelatin – $BaCl_2$ reagent was added and the volume was made up to mark. The optical density was taken from which the sulphate content was calculated.

3. RESULTS AND DISCUSSION

The results from the analysis of ashes from both agricultural wastes (ashed and charred palm bunch and plantain peels) are presented in Tables 1a, 1b, 1c and 1d. The trace elements: Fe, Mn, Cu, Cd, Pb, Zn, Co, Cr, Ni were below detection limits in the palm bunch ash (ash/charred) though some trace amounts of iron – 0.833±0.001 / 2.083±0.0003 mg/l, copper – 0.668±0.0003 / ND mg/l, cobalt – 1.323±0.018 / 2.015±0.019 mg/l cadmium – 0.211±0.013/ 0.309±0.062 mg/l were quantified in ashed/charred plantain peel. The ashed sample contained the highest amount of potassium, followed by chloride, sodium, phosphate, magnesium and the least was calcium. On the whole there were slight differences between the amount of the elements in charred and ashed samples. For example, the ashed palm bunch yielded 932.588±1.107 mg/l of potassium while the charred sample had 1200.000±1.633 mg/l. On the other hand, the ashed plantain peel gave 333.338±0.017mg/l of potassium with the charred peel yielding 333.648±0.547mg/l. These differences in the mineral contents of ash obtained through charring and ashing depends on the degree of combustion from the processes. During charring the materials are slowly combusted unlike complete combustion achieved through ashing [1,12].

These ashes from the agricultural wastes also were found to be rich in phosphate (mg/l): 184.070±0.009 in ashed palm bunch, 159.148±0.284 in its charred sample while charred and ashed plantain peel recorded 483.900±0.149 mg/l and 282.615±0.019 mg/l respectively. It has been suggested by researchers that these waste materials can be considered for use as organic fertilizer as in Somalia [9]. Palm bunch ash has been used as alternative fertilizer for mature oil palms on peat soils [13] and as a substitute for NPK fertilizer in maize growth [6]. It has also been reported that plant ash possesses qualities that give it several practical applications in industry, agriculture, medicine and in diets [14,15].

As a result of the alkali content of the potash from the ashes of the palm bunch and plantain peel they can serve as local raw material for soap production. The use of potash obtained from cassava peel, cocoa pod and plantain peel for the production of soap has been reported [16,17].

In fact palm ash is the scouring agent in some recipes for African black soap, which typically contain African palm oil. In the case of the Yoruba, Dudun-Osun brand of soap, palm bunch ash is a stated ingredient, which identifies the source as the African palm oil [7].

The high contents of the macrominerals- Na, K, Ca, P, etc. from the ashes of these agro wastes, also means they can be formulated into instant flours for convalescence and in the formulation of baby foods as these categories of humans require high levels of mineral for growth and repair. These wastes can be good sources of calcium, phosphorus and magnesium. Calcium and phosphorus are very important in the formation of strong bones and teeth, for growth, blood clotting, heart functions and cell metabolism [18].

Plantain wastes appear to be a potential source of nutrients for production of animal feeds and fertilizers. These wastes are very useful nutrients to both man and plants. Even the microelements such as iron which is responsible for formation of chlorophyll in plants and also is found in haemoglobin in the blood. All the other elements such as manganese, copper, cobalt, etc. found in these ashes of palm bunch and plantain peels are useful in one way or the other for both plants and animals [7,9,19]. The ashes were highly alkaline with pH of their solution greater than 10 ($pH < 10$). The pH values for the solutions of the ashes for palm bunch ash (ash / charred) were 11.037±0.002 and 9.905±0.001 while that for the plantain peels (ash/charred) were 11.040±0.013 and 10.898±0.547 respectively (Table 1). Plant ashes are usually alkaline ($pH < 10$) because they are composed primarily of calcium carbonate, potassium chloride and sodium chloride [7]. Plant ash is occasionally utilized as a substitute condiment when common salts or sea salts are unavailable [20]. The values for the total alkalinity for the palm bunch ash for ashed/ charred were 8997±3.830/ 3993.250±8.995 and for the plantain peel ash/charred were 128,993±24.211 and 158,021.500±43.000 respectively. These results also help buttress the fact that their solutions were highly alkaline.

The ashes from these wastes can be applied as an amendment to acidic soils and as substitute for limestone fertilizer. Vegetable waste ashes have been found to be a suitable replacement for up to 20% of portland cement in concrete [5].

Table 1a. Chemical composition of palm bunch; ashed and charred (raw data)

S/N	Parameters	Palm bunch							
		Ashed				Charred			
		1ST	2ND	3RD	4TH	1ST	2ND	3RD	4TH
1	P^H/Temperature 24ºC	11.038	11.036	11.038	11.034	9.905	9.912	9.903	9.901
2	Total alkalinity mg/l	9000	8996	8992	9000	4000	3986	3985	4002
3	Chloride content mg/l	2556	2558	2554	2.556	241	240	243	242
4	Ammonium content mg/l	1.480	1.460	1.450	1.480	1.520	1.500	1.520	1.540
5	Potassium content mg/l	933.330	933.240	932.820	930.960	1200	1202	1200	1198
6	Sodium content mg/l	6250	6248	6252	6249	500	498	502	496
7	Calcium content mg/l	32.500	30.360	31.480	32.460	145	147	148	146
8	Magnesium content mg/l	39.583	38.824	39.486	38.921	118.500	117.840	118.480	116.960
9	Nitrate content mg/l	1.060	1.040	1.040	1.060	2.000	2.020	2.010	2.000
10	Sulphate content mg/l	48.400	48.200	48.420	48.400	42.600	42.400	42.200	42.500
11	Iron content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
12	Manganese content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
13	Phospate content mg/l	184.100	184.000	183.980	184.200	159.380	159.400	158.960	158.850
14	Copper content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
15	Cadmium content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
16	Lead content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
17	Zinc content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
18	Nickel content mg/l	ND	ND	ND	ND	0.455	0.340	0.400	0.426
19	Cobalt content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
20	Chromium content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
21	Conductivity $\mu\pi^{-1}$ cm^{-1-}	40.320	40.400	40.530	40.300	32.890	32.500	32.860	32.640

ND – Not Detected

Table 1b. Chemical composition of plantain peels; ashed and charred (raw data)

S/N	Parameters	Plantain peels							
		Ashed				Charred			
		1ST	2ND	3RD	4TH	1ST	2ND	3RD	4TH
1	P^H/Temperature 24ºC	11.048	11.020	11.046	11.045	10.823	11.000	10.924	10.846
2	Total alkalinity mg/l	129000	128,984	128.965	129,022	158,000	158000	158086	158,000
3	Chloride content mg/l	9556	9556	9558	9554	17,040	17,050	17,040	17,060
4	Ammonium content mg/l	2.100	2.200	2.100	2.200	3.200	3.220	3.000	3.200
5	Potassium content mg/l	333.330	333.340	333.360	333.320	333.330	333.050	334.000	334.210
6	Sodium content mg/l	27,000	27,000	27,020	27,014	3,725	3,728	3,726	3,725
7	Calcium content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
8	Magnesium content mg/l	16,917	16,918	16,918	16,916	0.333	0.335	0.342	0.334
9	Nitrate content mg/l	1.200	1.220	1.240	1.200	2.800	2.900	2.800	2.900
10	Sulphate content mg/l	30.480	30.460	30.480	30.480	36.200	36.200	36.240	36.220
11	Phospate content mg/l	282.600	282.620	282.640	282.600	483.800	484.120	483.860	483.820
12	Iron content mg/l	0.833	0.832	0.834	0.834	2.083	2.082	2.083	2.082
13	Manganese content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
14	Copper content mg/l	0.667	0.667	0.668	0.668	ND	ND	ND	ND
15	Cadmium content mg/l	0.200	0.200	0.221	0.224	0.300	0.312	0.314	0.308
16	Lead content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
17	Zinc content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
18	Nickel content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
19	Cobalt content mg/l	1.330	1.320	1.340	1.300	2.000	2.020	2.040	2.000
20	Chromium content mg/l	ND	ND	ND	ND	ND	ND	ND	ND
21	Conductivity $\mu\pi^{-1}$ cm^{-1-}	54.950	54.260	54.980	54.940	27.170	27.180	27.160	27.170

ND – Not Detected

Table 1c. Statistical analysis of data on Table 1a

S/N	Parameters	MEAN ± S.D (mg/l)	
		Ashed sample	**Charred sample**
1	P^H/Temperature 24ºC	11.037±0.002	9.905±0.001
2	Total alkalinity mg/l	8997±3.830	3993.250±8.995
3	Chloride content mg/l	2556±1.630	241.500±1.291
4	Ammonium content mg/l	1.468±0.015	1.520±0.016
5	Potassium content mg/l	932.588±1.107	1200.000±1.633
6	Sodium content mg/l	6249.750±1.708	499.000±2.582
7	Calcium content mg/l	31.700±1.010	146.500±1.291
8	Magnesium content mg/l	39.204±0.387	117.945±0.725
9	Nitrate content mg/l	1.050±0.012	2.008±0.095
10	Sulphate content mg/l	48.355±0.104	42.425±0.171
11	Iron content mg/l	ND	ND
12	Manganese content mg/l	ND	ND
13	Phospate content mg/l	184.070±0.009	159.148±0.284
14	Copper content mg/l	ND	ND
15	Cadmium content mg/l	ND	ND
16	Lead content mg/l	ND	ND
17	Zinc content mg/l	ND	ND
18	Nickel content mg/l	ND	0.405±0.008
19	Cobalt content mg/l	ND	ND
20	Chromium content mg/l	ND	ND
21	Conductivity $\mu\pi^{-1}$ cm^{-1-}	40.388±0.104	32.723±0.186

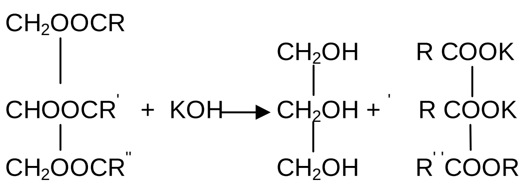
ND – Not Detected
SD – Standard Deviation
Mg/L – Milligram per Litre

Table 1d. Statistical analysis of data on Table 1b

S/N	Parameters	MEAN ± S.D (mg/l)	
		Ashed sample	**Charred sample**
1	P^H/Temperature 24ºC	11.040±0.013	10.898±0.521
2	Total alkalinity mg/l	128,993±24.211	158021.500±43.000
3	Chloride content mg/l	9556.000±1.633	17047.500±9.574
4	Ammonium content mg/l	2.150±0.006	3.155±0.104
5	Potassium content mg/l	333.338±0.017	333.648±0.547
6	Sodium content mg/l	27008.500±10.116	3726.000±1.414
7	Calcium content mg/l	ND	ND
8	Magnesium content mg/l	16917.250±0.957	0.336±0.040
9	Nitrate content mg/l	1.215±0.006	2.850±0.006
10	Sulphate content mg/l	30.475±0.010	36.215±0.019
11	Iron content mg/l	282.615±0.019	483.900±0.419
12	Manganese content mg/l	0.833±0.001	2.083±0.0003
13	Phospate content mg/l	ND	ND
14	Copper content mg/l	0.668±0.0003	ND
15	Cadmium content mg/l	0.211±0.013	0.309±0.062
16	Lead content mg/l	ND	ND
17	Zinc content mg/l	ND	ND
18	Nickel content mg/l	ND	ND
19	Cobalt content mg/l	1.323±0.018	2.015±0.019
20	Chromium content mg/l	ND	ND
21	Conductivity $\mu\pi^{-1}$ cm^{-1-}	54.783±0.302	27.170±0.008

ND – Not Detected
SD – Standard Deviation
Mg/L – Milligram per Litre

As a result of its alkailine nature arising from the high level of potash (KOH), the ashes from both palm bunch and plantain peel when leached with water and the filtrate reacted to produce a yellow alkaline mixture known in Efik local language as '*otong*'. This '*otong*' is a special type of soup among the many delicacies found in southern Nigeria. In its preparation, the fat/oil reacts with the potash from the water-leached solution of the ash. The equation of the reaction in the production of this '*otong*' is



glycerol
'otong' soup

'*Otong*' is prepared by measuring 1 cm^3 of the leached solutions of plantain ash and 1 cm^3 of red palm oil added to it in a beaker. The mixture turned yellow and this process is saponification. The alkali (KOH) present in the ash solutions breaks down the free fatty acid in the oil and turns it to the potassium salt of the oil [19].

4. CONCLUSION

Both palm bunch and plantain peels are agro byproducts which are often discarded as waste and litter the environment indiscriminately.

However, from the study, these wastes possess qualities that give several practical applications in the industry, and agriculture. The potash present in them is an important raw material in soap production and is fertilizer in soil neutralization. Also, the plantain wastes appear to be good sources of nutrients for production of animal feeds, formulation of baby foods and the convalescence. The wastes were high in potassium, sodium, calcium, phosphorus and can be good source of these minerals for both animals and plants. The ashes from the palm bunch and plantain peels could be formulated into NPK fertilizer. Apart from the fact that our environment would be free of these agricultural wastes discarded indiscriminately, it will save the environment from the potential harmful effect of pollution that associate with these wastes. In addition, the heavy dependence on synthetic chemicals for the production of soap, fertilizers, animal feels and others would be drastically reduced if efforts are made in producing these raw materials locally. This venture can generate self employment for our teeming unemployed youths roaming the streets in search of white collar jobs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Akunna TO, Ahaotu EO, Oseji CN, Ibeh CC. Production of soap using Palm Bunch Ash. Inter. J. Appl. Sci. Engr. 2013;1(2): 79-82.
2. Onifade KR. The application of cocoa pods husks for the manufacture of caustic potash. Journal of Agric. Technol. 1994;2: 59-64.
3. Onyegbado CO. Feasibility of soap production for bright future soap industries. Private Communications; 1984.
4. Adewuji GO, Obi-Egbedo NO, Babayemi JO. Evaluation of ten different African wood species for potash production. International J. Phys. Sci. 2008;3:63-68.
5. Sata V, Jaturapitakkul and Kiattikomol K. Utilization of palm oil, ash fuel in high-strength concrete. J. Maters. Civil origin. 2004;16:623-628.
6. Awodun MA, Oheniyi SO, Adeboye A, Odedina SA. Effect of oil palm bunch refuse ash on soil and plant nutrient composition and yield of maize. Am. Evr. J. Sust. Agric. 2007;1:50-54.
7. Johnson DV. Palm Ash: A humble product of many uses. Palm Ash. 2011;55(3):117-121.
8. Osma JF, Herreva JLT, Couto SR. Banana Skin; A novel waste for lactase production by *Tramets pubescens* under solid-sate conditions. Applications to synthetic dye decolouration. Dye Pigments. 2007;85:32-37.
9. Okareh OT, Adeolu AT, Adepoju OT. Proximate and mineral composition of plantain (*Musa paradisiaca*) wastes flour; a potential nutrients source in the formulation of animal feeds. Afri. J. Food Sci. and Technol. 2015;6(2):53-57.
10. Gill LS. Ethnomedicinal uses of plants in Nigeria. University of Benin Press, Benin City; 1992.
11. Adeniyi TA, Sanni LO, Barrimalaa IS, Hart AD. Determination of micronutrients and

colour variability among new plantain and banana hybrids flours. World J. Chem. 2006;1(1):23-27.

12. Kirk R, Othmer DF. Encyclopedia. Technol. 3rd Edn; 1994.
13. Othman H, Mohammed AT, Dolmat MT. Bunch ash: An efficient and cost effective K. Fertilizer source for mature oil palm on peat under high rainfall environment. MPOB Inf. Ser. 2005;254.
14. Ohtsuka R, Suzuki T, Morita M. Sodium-rich free ash as a native salt source in low land Papua. Economic Botany. 1988;42: 55-59.
15. Bonneau X, Harynato I, Karsiwas T. Coconut husk ash as fertilizer for coconut palms on peat. Experimental Agriculture. 2010;46:404-14.
16. Taiwo OE, Osinowo FA. Evaluation of various agro-wastes for traditional soap production. Biores. Technol. 2001;79:95-97.
17. Onyegbado CO, Iyagba T, Offor OJ. Solid soap production using plantain peels ashes as a source of alkali. J. Appl. Sci. and Env. Mgt, 2004;6:73-77.
18. Roth AR, Townsend CE. Nutrition and diet therapy, 8th edn, Delmar learning. Thompson Hearing Inc. Canada; 2003.
19. Adele MN. Studies on some Agricultural wastes; plantain peels and palm bunch. B. Sc. Thesis Department of Chemistry and Biochemistry. University of Uyo, Nigeria; 1998.
20. Andrews AP. Maya salt production and Trade. University of Arizona, Press, Tuscon; 1983.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/15056