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Alkali Extracts from Banana Peels Ash Used in Removing Metals from Metals Polluted Water from Abakaliki, Ebonyi State

John Jedidiah
Department of industrial Chemistry, Ebonyi State University, PMB 053, Abakaliki, Nigeria.

Abstract: *The purpose of this work is to document the alkalis metal level of banana peels ash with a view of using it as a source of alkali for metals removal from metals polluted water. This was carried out by ashing the peels and dissolving it in distilled de – ionized water. The analysis on the solution was done using Atomic Absorption Spectroscopy (AAS) (Buck 205). The level of essential metals appear in this order: K > Fe > Ca > Mg > Mn > Zn > Na. Potash content obtained was 26.4% of 100g banana peels ash used which gave percentage purity of 69% and a purity of 80% on re-crystallization. The toxic element (lead) in the ash was within the limit of World Health Organization (WHO, 2011). The ash was characterized using X – Ray Diffraction (XRD) which gave a sharp peak at 2 theta = 28.5^O and Brunauer Emett Teller (BET) which gave the surface area and pore size as $63.27m^2g^{-1}$ and 21.07 A^o respectively. The efficacy of the alkalis were tested in five borehole water invested with metals at Abakaliki between Nov. 2017 – Jan. 2018 and May – July, 2018. Results showed that the following metals Al, Ca, Cr, Cu, Mg, Mn, Pb, Na, and Zn except K were reduced in all the water samples for both periods.*

Key Words: *Banana peels ash, alkalis, essential elements, toxic elements, metals, polluted water.*

I. Introduction

Banana (*Musa sapietum)* plant is one of family called Musaceae. It is cultivated throughout the tropics [1] and for the purpose of its fruits [2]. It is assumed to be an ornamental plant and the fruit is covered by its peel which is thrown away as waste after the inner fleshy portion is eaten or used in industries that make use of it.

Banana fruits prevent anaemia, reduce blood pressure, reduces the problem of constipation and can cure heart burns stress, strokes, ulcers, etc [3]. Charcoals made of banana peels when coupled with other materials can produce liniment for reducing the pains or acuteness of arthritis [4]. [5] stated that agricultural waste materials like banana peels, banana leaves, maize cob, palm bunch, etc contain a good percentage of potash. This material when ashed and dissolved in water gives hydroxides of K and Na [6]; [7].

Food and Agriculture Organization (FAO, 1988) documented 5,879,000 metric tonnes of banana peels in African countries as cited by [8]. These wastes could be efficiently put in to use for other valuable industrial, agricultural or domestic purposes, thereby reducing environmental pollution especially in countries such as Nigeria where most agro-base wastes are mostly subjected to open-air burning and open air piths.

Although water is necessary for life, it could also be a channel of transmission of diseases and death [9]; [10]. Water is contaminated when it contains a chemical or biological poison or infectious agent that is harmful to living system [11]. Water sources with fecal or metal contaminations can transmit water borne diseases such as cholera, typhoid, diarrhea, etc [12].

Numerous studies on water bodies have shown presence of metals in both surface and ground water sources in Ebonyi State due to its geological strata [13]; [14]. Investigations have shown that both essential and non essential metals at excessive amounts are toxic since they do not degrade, but tend to accumulate in human [15]. Water bodies contaminated with metals are the route of ill-health in human and animals. Although, it is difficult to classify metals into essential and toxic groups, it is a well known fact that an essential metal becomes toxic at sufficiently high intakes [16]. For instance, excess lead causes serious damage to the brain, kidneys, nervous system and red blood cells [17]. Although zinc is essential to both human and animals' health at low intake it causes poorly developed sex organs and retarded growth in young men, while at excessively high level, zinc causes stomach anemia, damage the pancreas [18]. This study investigated the effectiveness of the alkali from banana peels ash in removing metals from five boreholes used as sources of drinking water at Abakaliki, Ebonyi State, Nigeria between Nov. 2017 to Jan. 2018 and May – July, 2018. Although the study may have been out ease way, none has been reported in Ebonyi state, Nigeria.

II. Materials And Method

All the reagents used were of analytical grade (Merck products, Germany). These were used without further purification. However, dilutions were made where necessary.

Preparation of Ash from Banana (*Musa sapientum*) Peel Wastes:

Unripe banana bunch bought at Eke market, Ezzamgbo was washed with distilled water and peeled. The peels were sun dried for four days and oven dried for 2 hrs at 200 ± 5^oC. Weighed 500.0 g of the peels were ashed using zinc sheet, sieved and then allowed to cool for 3hrs and weighed according to the methods of [19] [20]. The calculation was as follows:

% of Ash Content = X/500 x 100/1

% Loss of weight = 500-X/500 x 100/1

Test of the Bascity of the Ash Content:

Ash of 2.0g was dissolved in 100 mL beaker with de-ionized water, when tested with universal pH paper gave a blue dark purple colour, pink with phenolphthalein indicator and yellow with methyl orange indicator showing bascity.

Extraction of potash from the ash

Weighed 5.00 g of the ash sample were added to 75 cc plastic bottle and 100 cm^3 of de-ionized water added, and clamped with retort stand for 18hrs. Using syringe, 5 holes were made on the plastic bottle, after the cover of the bottle was removed, while the extract was collected with 100 cm^3 glass beaker. After 24 hrs, 80.00 cm^3 of the extract was collected and reduced to 20.00 cm^3 by heating on water bath at 80^oC, then transfer to weighed crucible, evaporated to dryness in an oven and cooled to a constant weight and weighed.

Calculation:

80 cm^3 of extract solution weigh X

100 cm^3 of extract solution will weigh X/80 x 100/1 = Y

% yield of potash x/y x 100/1 = Z %.

Purity of the ash

The method of [21] was used in determining the purity of the ash. Crude potash of 0.2 g was dissolved with de-ionized water in 50 cm^3 volumetric flask and made to the mark. The solution (10 mL) was pipetted into 100 cm^3 conical flask and diluted to 25.0 cm^3 with distilled water, then 2 drops of methyl orange added and titrated against 0.1M HCl. Three replicates were obtained and in duplicate analysis. The reaction above is shown in equation 1.

$$K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O \quad (1)$$

Determination of Hydroxide and Trioxocarbonate (IV) contents of the ash

Double indicator acid-base titration was used according to the methods of [22]. Ten (10) cm^3 of the mixture was pipette into 100cm^3 conical flask and 2 drops of phenolphthalein was added and then titrated against 0.1M HCl to colourless end point and reading taken. Then 2 drop of methyl orange was added to mixture and titrated from yellow to pink. The phenolphthalein indicator neutralized all the hydroxides and converts the carbonates to bicarbonates, while methyl orange indicator converts bicarbonates to carbon (IV) oxide and water.

Equation of reactions: Phenolphthalein Indicator;

$$KOH + HCl \rightarrow KCl + H_2O \quad (2)$$

$$K_2CO_3 + HCl \rightarrow KCl + KHCO_3 \quad (3)$$

Methyl orange Indicator;

$$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2 \quad (4)$$

Calculation:

0.1 M HCl required to neutralize

KOH = V- Vi

M HCl required to neutralize

K_2CO_3 = 2Vi

Molar concentration of KOH 0.1M (V-Vi)/10 = X

Gram concentration Of KOH = molar mass x X = Y

Molar concentration of K_2CO_3 = 0.1M (2Vi)/20 = a

Gram concentration of K_2CO_3 = molar mass x a = b

3.9.4 Analysis of the Elements present in the ash

The elemental analysis of the ash sample was carried out using the method of [23] where 0.5 g of the ash sample was weighed into 100 cm^3 beaker and 50 mL of 1: 1 HNO_3 added. The beaker was placed on a water bath and boiled to reduce the sample to 10 mL and more 20 mL of 1:1 HNO_3 added to the solution and the volume finally reduced to 15 mL, then filtered with Whatman No. 41 filter paper. The filter paper and beaker were washed with

0.1 M HNO_3, while the filtrate was transfer to 50 cm^3 volumetric flask and made to mark with de-ionized water and analyzed using Buck 205 AAS (Buck Scientific, Norwalk).

Characterization of the banana peels ash

The ash was characterized using X – Ray Diffraction (XRD) patterns were measured on a Bruker® D8 Discover diffractom- eter using Cu-Karadiation (l ¼ 1.5405 Å) source connected to a Lynx Eye detector and Brunauer Emmett Teller (BET) measured with micrometric ASAP2020 system with nitrogen being the adsorbate gas.

III. Results And Discussion

Table 1: Metal Concentration and percentage of ash from banana peels

Element	Concentrations ($mgkg^{-1}$)	Percentage
Ca	103.43 ± 0.011	13.09 ± 1.1
Mg	52.04 ± 0.017	7.08± 1.7
K	451.00 ± 0.010	59.34± 1.0
Fe	56.09 ± 0.009	7.43± 0.9
Na	53.30 ± 0.012	7.06± 1.2
Mn	16.00 ± 0.002	2.12± 0.2
Cu	2.44 ± 0.005	0.32± 0.5
Zn	20.40 ± 0.000	2.70± 0.0
Pb	0.005 ± 0.002	0.007± 0.2
Ni	0.05 ± 0.000	0.007 ± 0.0
Al	0.02 ± 0.010	0.003± 1.0
Cr	0.04 ± 0,110	0.005± 11

Table 1 shows the metal composition in $mgKg^{-1}$ and the percentage of ash from unripe banana peels. According to the table, the metals in the banana peel ash were in the order k > Ca > Fe >
Na > Mg > Zn > Mn > Cu > Pb > Ni > Cr > Al and differs from the report of [24]. However, [4] [5] [6] indicted that metals present in unripe banana peels may differ because of the nature of the soil and diversities in agricultural practices in different places.

While metals such as Mg and Fe are important for growth and in building up the red blood cells, Ca is important in bone and teeth formation, Zn and Mn promote the activities of many enzymes in the body [9]. The high ratio of potassium to sodium in the peels is a welcome development since high level of potassium to sodium decreases high blood pressure and muscle cramp [15]. The toxic elements such as lead, being below WHO guideline limit showed that banana peels are safe to be used in reducing heavy metals from heavy metals contaminant water.

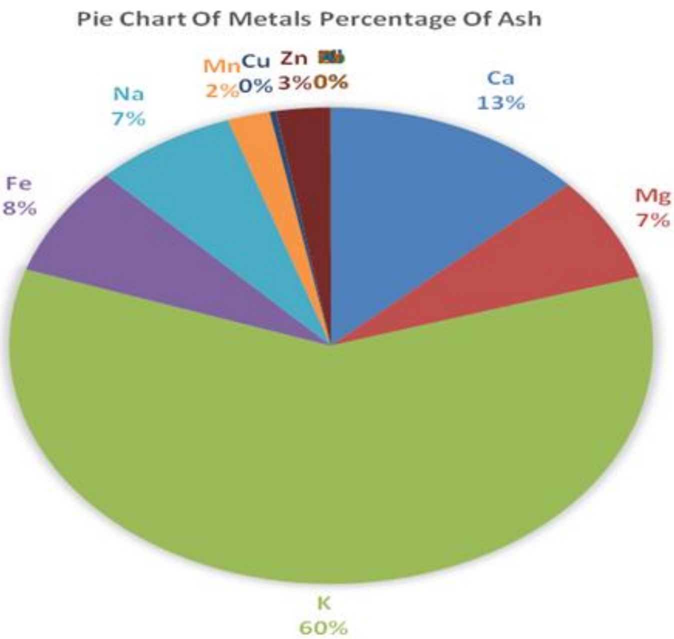

Fig.1: Metal concentrations of banana peel ash in percentages

Figure 1 presented the metal contents of banana peels in Table 1 in pie chart form in which potash (K) has about 60% of the metal contents.

Characterization of banana peels ash

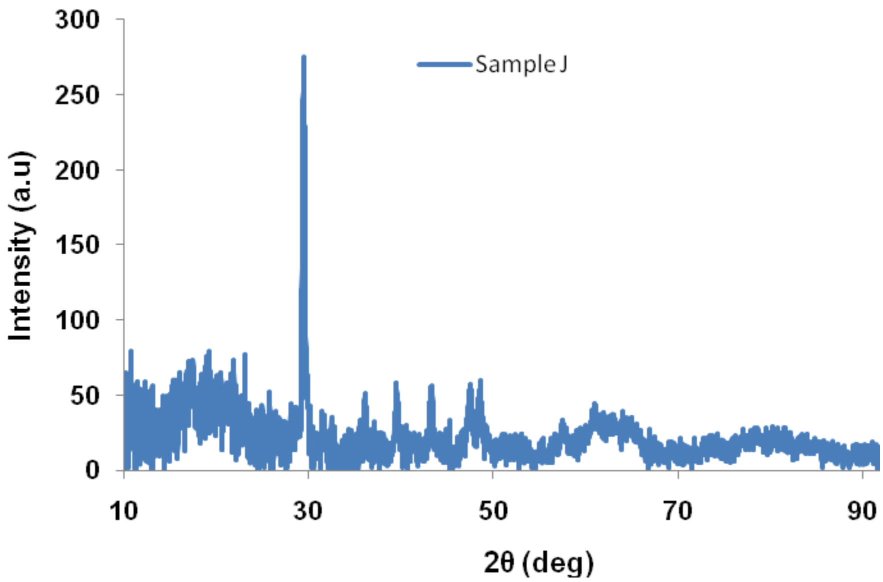

Fig. 2: XRD Diffraction plot of volume against 2 theta degrees

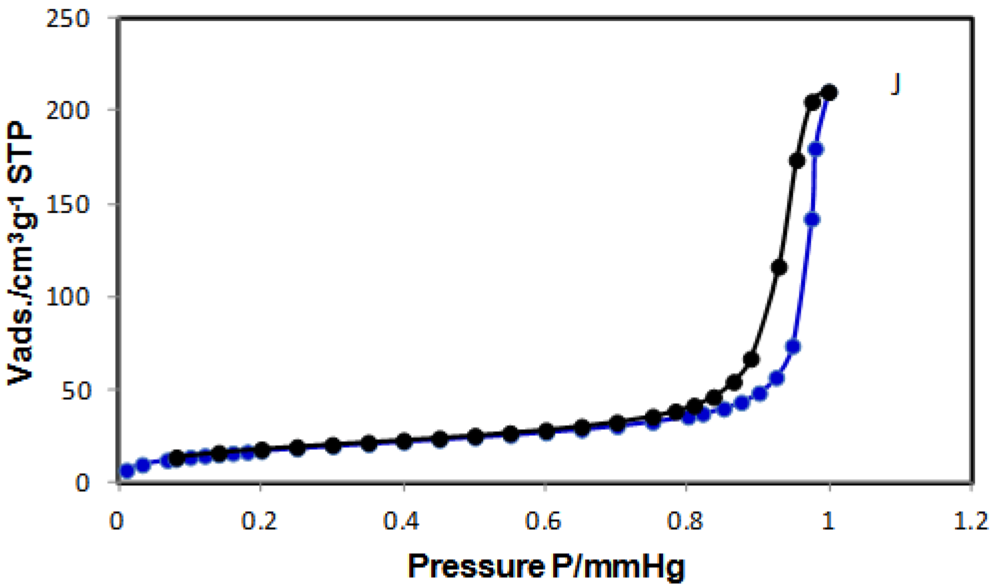

Fig. 3: BET plot of adsorption / desorption of the gas molecule

The X – Ray diffraction pattern for banana peels ash is shown in figure 1. The XRD diffractometer revealed that the ash was heterogeneous, partly amorphous and partly crystallite. The main peak at 28.5^o *at* (2 theta) demonstrated crystallite response to XRD spectra which is consistent potassium oxide crystal cubic face, while the broad nature of the peak illustrated the amorphous character which correspond with the report Nwanji et al., (2017). The XRD showed a broad peak in the 2 theta equal to 50 to 100 which indicates the amorphous nature of the ash.

Figure 2 shows BET plot of volume of gas adsorbed (vads./cm3g-1), in this case nitrogen gas was plotted against pressure P/mmHg at constant temperature. It is characterized by heats of adsorption being less than the adsorbate heat of liquefaction. The figure showed a slight linear curve from 0 - 0.8 mmHg which was characterized by the heat of adsorption being less than adsorbate heat of liquidifaction. However, adsorption increased as the interaction with the adsorbed layer became greater than interaction with the adsorbent surface (0.8 – 1.0 mmHg). This agrees with the report of [24]. The second curve showed the desorption after equilibrium was reached. The result revealed that the surface area was 63.67m2g-1 while the pore size was 21.07nm, an indication that high surface area and pore size contributed to the excellent performance of banana peels ash as an adsorbent.

Table 2: Mean Metal Concentrations of Abakaliki Borehole Water Samples before and after treatments from Nov. 2017 to Jan. 2018.

Locations	PRESCO		CAS		Isheke		Kpirikpiri		Prisons		WHO 2011
metals (mgL-1)	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	-
Aluminium	0.03±0.00	0.007±0.00	0.02±0.01	0.004±0.00	0.04±0.0.02	0.009±0.02	0.02±0.01	ND	0.04±0.00	0.008±0.01	0.02
Calcium	52.8±0.08	14.4±0.12	48.0±0.21	24.0±0.10	49.0±0.17	2.70±0.12	39±0.09	16.0±0.11	32±0.02	19.0±0.21	75
Cadmium	0.40±0.01	0.02±0.00	0.20±0.03	0.03±0.00	0.2±0.00	0.03±0.01	0.10±0,00	0.02±0.05	0.3±0.01	0.02±0.00	75
Chromium	0.08±0.03	0.01±0.01	0.04±0.00	ND	0.06±0.0.01	ND	0.07±0.01	0.01±0.02	0.05±0.00	0.01±0.02	1.5
Copper	0.61±0.00	0.01±0.02	0.31±0.04	ND	0.58±0.07	0.008±0.00	0.4±0.09	0.07±0.06	0.5±0.03	0.02±0.05	0.05
Magnesium	17.7±0.21	7.20±0.12	22.1±0.01	8.4±0.07	16.9±0.21	6.20±0.09	14.5±0.01	8.00±0.08	14.7±0.11	7.40±0.08	50
Manganese	0.04±0.01	ND	0.07±0.00	0.01±0.0,00	ND	ND	0.72±0.02	0.05±0.01	0.09±0.02	0.01±0.02	0.05
Lead	0.14±0.07	0.01±0.05	0.15±0.01	0.010±0.00	0.14±0.05	0.01±0.03	0.18±0.03	0.02±0.03	0.07±0.07	0.01±0.01	0.01
Potassium	1.61±0.04	2.00±0.01	2.58±0.03	2.84±0.13	0.41±0.02	0.60±0,07	4.82±0.00	5.05±0.06	3.64±0.09	3.85±0.09	-
Sodium	3.40±0.17	0.25±0.09	4.30±0.01	0.76±0.09	4.3±0,14	0.23±0.01	5.40±0.02	0.45±0.01	3.21±0.01	0.46±0.10	100
Zinc	0.80±0.02	0.003±0.05	1.02±0.02	0.09±0.01	0.74±0,04	0.06±0.09	0.6±0.0.05	0.03±0.02	0.42±0.08	0.02±0.04	5.0

BT means before treatment, AT means after treatment, ND means not detected.

Table 3: Mean Metal concentrations of Abakaliki Borehole Water Samples before and after treatments from May,.2018 to July, 2018

Locations	PRESCO		CAS		Isieke		Kpirikpiri		Prisons		WHO 2011
Metals (mgL^{-1})	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	
Aluminium	0.02±0.02	ND	0.02±0.03	0.003±0.00	0.03±0.10	0.08±0.01	0.02±0.01	0.003±0.00	0.04±0.03	0.007±0.00	0.02
Calcium	51.0±0,10	14±0.03	46±0.0	23±0.09	49±0.33	24±0..11	38±0.02	10.0±0.60	31±0.24	18±0.08	75
Cadmium	0.36±0.11	0.03±0.00	0.17±0.05	0.02±0.01	0.11±0.08	0.01±0.00	0.41±0.09	0.03±0.05	0.05±0.00	ND	0.05
Chromium	0.05±0.01	ND	0.03±0.00	ND	0.05±0.01	0.01±0.00	0.06±0.10	0.01±0.00	0.03±0.01	ND	0.01
Copper	0.52±0.09	0.02±0.02	0.21±0.09	ND	0.30±0.04	0.01±0.02	0.60±0.12	0.08±0.02	0.40±0.02	0.01±0.00	1.50
Magnesium	17±0.21	7±0.04	20±0.17	8.40±0.02	16.0±0.21	7.0±0.12	15±0.02	7.90±0.08	14.5±0.14	7.2±0.11	50
Manganese	0.03±0.08.	ND	0.06±0.03	0.01±0.01	0.02±0.02	ND	0.70±0.08	0.05±0.02	0.07±0.11	ND	0.05
Lead	0.13±0.07	ND	0.92±0.01	0.01±0.02	0.13±0.02	ND	0.14±0.04	0.01±0.0.00	0.17±0.02	0.01±0.10	0.05
Potassium	1.53±0.11	1.97±0.09	2.34±0.11	2.61±0.03	0.37±0.01	0.53±0.05	4.57±0.11	5.02±0.21	3.43±0.02	3.59±0.03	-
Sodium	3.23±0.18	0.21±0.06	4.24±0.03	0.18±0.02	4.27±0.11	0.21±0.06	5.28±0.04	0.36±0.02	3.18±0.10	0.42±0.40	100
Zinc	0.6±0.02	0.02±0.01	0.80±0.02	0.06±0.02	0.06±0.02	0.05±0.02	0.4±0.01	0.01±0.01	0.50±0.03	0.01±0.04	5.0

BT means before treatment, AT means after treatment, ND means not detected.

Tables 2, and 3 showed the mean metal concentrations of borehole water samples in Abakaliki from November, 2018 to January, 2019 (dry season) and May to July, 2019 (rainy season) compared with WHO's standard. From the tables, we observed that aluminum was high in presco ($0.3mgL^{-1}$), Isieke ($0.4mgL^{-1}$) and prisons ($0.4mgL^{-1}$) boreholes from November, 2017 to January, 2019. Only prisons borehole with $0.4mgL^{-1}$ was high between May to July, 2019 and those drinking any of the boreholes without treatment may be at risk of Alzheimer's disease (Lee, 2009). The tables also revealed that Presco has levels of cadmium (0.4 and 0.36 mgL^{-1}), chromium (0.08 and 0.05 mgL^{-1}) and lead (0.14 and $0.13mgL^{-1}$) which exceeded the WHO's recommended values of 0.05, 0.05 and 0.01 mgL^{-1} both in the November, 2018 to January, 2019 and May to July, 2019 for the respective elements in the water samples before treatment. The presence of these trace metals in excess indicates danger and drinking such boreholes without treatment may suffer liver and kidney damages, asthma and permanent disability [7]; [8]. However, in the treated (BT) water samples both essential metals like copper, sodium and zinc as well as the non essential metals such as lead, cadmium, etc were reduced to the WHO's recommended limits, showing the efficacy of banana peels ash in removing heavy metals from water. The same was applicable to Cas, Isheke, Kpirikpiri and Prisons water samples as shown by the tables 2 and 3. Potassium was not reduced in all the treated water samples which could be due to ion effect as a result of high content of the ash coupled with the high surface area and pore size. It may also be as a result of many functional groups – CO_2^-, OH^-, $-NH_2$, etc present in banana peels ash which may bind the metals and remove them either through ion exchange or complex formation [11]; [12]; [13]

IV. Conclusion

The results of the analysis showed that banana peels ash is alkaline in nature and has the potentials to remove metals from metals contaminated water. Depending on the concentrations, all the metals were either removed or reduced in all the treated samples except potassium.

References

[1]. Abbasi, Z; Alikarami, M; Nezhad, E. R; Moradi, F and Moradi, V. (2013). Adsorbent removal of Co^{2+} and Ni^{2+} by peels of Banana from aqueous solution. *Universal Journal of Chemistry 1 (3): 90 - 95*

[2]. Afiukwa, J. N.. Arua, S. N. and Beckie, J. I. (2009). Heavy Metal Analysis of some drinking Water Sources and the Status of Water Related Diseases Cases in Ebonyi State, Nigeria. *Journal Research in Physical Science, 5* (3), 98-103.

[3]. Akinyosonye, V. O (1991). Tropical Agriculture, Macmillan Publishers Limited, Ibadan, 65-68.

[4]. Anhwange, B.A; Ugye, T.I and Nyiaatagber, T.D (2009). *Electronic Journal of Environmental, Agricultural and Food Chemistry* 8 (6), 437 – 442.

[5]. A.Thirulogachandar, M.E; Rajeswari, M and Ramya, S (2014). Assessment of Heavy Metals in Gallus and their Imparts on Human. *International Journal of Scientific and Research Publications*. Vol. 4. Issue 6. June 2014. www.ijsrp.org

[6]. Babayemi, J.O; Dauda, K.T, Nwude, D.O and Kayode, A.A.A (2010). Evaluation of the Composition Chemistry of Ash and Potash Various Plant Materials-A review: *Journal of Applied Sciences* 10:1820–4.

[7]. Gupta, W. K;ad Nayak, M and Agarwal, S (2015). Bioadsorbent for remediation of the heavy metals. Current status and their future prospects. Environment Engineering Research 2015: 20 (1) 1 – 18.

[8]. Herron, H. A. and Delko, G. (2006). Water Stories. http://www.unesen .org/water/wwd 2006/world-view/water-Language-hun. Retrieved 3 June, 2018

[9]. Hussein, K.H; Osama, A.A; Hadad, A.S and Mohammed, F.M (2012). Environmental Assessment of Ground Water Pollution by Heavy Metals and Bioaccumulayion of Mercury Residues in Chicken Tissues African Journal of Biotechnology vol. 10(71), pp 16089-16100.

[10]. Leslie, S. C (1976). An Introduction to the Botany of Tropical crops (2nd edition), Longman Group Limited, London, 153 – 155.

[11]. Ng, S.P and Fong, C.S (2000). Banana Enhances your Anti-cancer Power In: Health Discovery. Petaling Jaya Malalysia: life Publisher Berhad.

[12]. Nwaji, N., Jones, B., Mack, J., Oluwole, D. O. and Nyokong, T.(2017). Nonlinear optical dynamics of benzothiazole derivatized phthalocyanines in solution, thinfilmsand when conjugated to nanoparticles *Journal of Photochemistry and Photobiology A: Chemstry* 346: 46 – 59

[13]. Ojokuku, G.O (2001). Practical Chemistry for Schools and Colleges, University Press Plc, Ibadan. 40-53.

[14]. Ogundiran, M.B; Babayemi, J.O and Nzeribe, C.G (2011). Determination of Metal Content and An Assessment of Potential Use of Waste Cashew Nut Ash (CNSA) as a Source for Potash Production. *Bioresources* 6(1) 529-536.

[15]. Olabanji, O; Oluyemi, E.A and Ajayi, S.O (2012). Metal Analysis of Ash Derived Alkalis from Banana and Plantain Peels (Musa Spp) in Soap Making. *African Journal of Biotechnology* Vol. 11(99) pp 16512-8.

[16]. Onyegbado, C.O; Iyagba, E. T and Offor, O. J (2002). Solid Soap production using plantain peels ash as source of alkali. Journal of Applied Science and Environmental Management, 6: 73 – 77.

[17]. Organization for Economic Cooperation and Developing of Water and Sanitation Services in Developing Countries Paris: OECD. http.//www.Oecd. Org/detaoecd/27/22/2955840.df. Retrieved 3 June, 2018.

[18]. Sabine, M and Wendy, G (2009). Human Health Effects of Heavy Metals. *Environmental Science and Technology Briefs for Citizens*. www.engg.ksu.edu/CHSR/issue 15.

[19]. Siddique, A. K., Eusof, A. and Zaman, K. (1991). Floods of 1988 in Bangladesh: Pattern of Illness and Causes of Dealth. *Journal of Diarrhea Disease Research, 9*(4): 310 - 314.

[20]. Spearman, S. A. (2017). An X – ray Diffraction patterns. http://prism.mit.edu/xray. Retrieved 19 July, 2017.

[21]. Shyamala, B.N and Jamuna, P (2011). Chemical Composition and Antioxidant Potential of Peels from three varieties of Banana. *Asian Journal of Food and Agro Industry, 4(01), 31-46.*

[22]. Sud, D; Mahajan, G and Kaur, M. P. (2008). Agricultural waste material as potential adsorbent for sequestering Heavy Metal ions from aqueous solutions. *Journal of Bioresource Technology*. Vol. 99, Issue 14. 2008: 6017 – 6027.

[23]. Udedi, S.S. (2003). From Guineaworm Scourage to Metal Toxicity in Ebonyi State, Chemistry in Nigeria: A National Magazine of the Chemical Society of Nigeria, 2 (2): 13 – 14.

[24]. Wong, Y. C., Wong, C. T., Onyiruka, S. O and Akpanisi, I. E. (2002). University General

[25]. Chemistry, Inorganic and Physical, Africana Fep Publication, Onitsha. 732.