Evaluation of Recoverable Potash from Coconut Husk, Plantain Peel and Cocoa Pod Husk through Leaching

Odunlami, M.O.*, Folami, N.A., Oso, A.O., Omoboh, J.I.
Department of Chemical Engineering, Lagos State Polytechnic, Ikorodu, Lagos, Nigeria
**Corresponding Author*

Abstract: - **The aim of this work was to extract potash from three agricultural wastes namely: coconut husk, plantain peel and cocoa pod husk. In each of the experiments, The potash was extracted from wastes using water and the extract was titrated against 1.0 M HCl using methyl orange as indicator. The concentration of potash was determined using UV Spectrophotometer. The results showed that sodium in the extracts from cocoa pod, plantain peel and coconut husk were 542.083 ppm, 302.592 ppm and 204.16 ppm respectively. The agricultural wastes used are suitable for use in the extraction of potassium for soap making and environmentally friendly.**

Key words: **Leaching, potash, coconut husk, plantain peel and cocoa pod husk**

I. INTRODUCTION

Potash is the trade term commonly applied to crude potassium carbonate obtained by leaching the ashes of burnt plant and animal bones with water and evaporating the resulting solution to dryness (Shagal, 2011). That is, it is a white crystalline residue that remains after aqueous extract from ashes has been evaporated (Kevin, 2003). Potash washed from wood or other biomass fibers is used to produce crude soap when reacted with the required volume of other potassium compounds, road construction cold asphalt manufacturing, shoe polish, and production of potassium. The highest soluble metal is potassium, though this depends on the species of the plant material and the type of soil where the plant grows (Babayemi et al., 2010). Potassium is the seventh most abundant element in the earth crust and it is in high demand in several countries of the world. Also, potassium is employed in fertilizer production (as an essential nutrient for plant growth), cement industry, soap making, production of glass, ink, dye and matches, electroplating processes, production of anti-freezing and cleansing agents, production of pesticides for farm crops and leather tanning (Babayemi et al, 2009). Potash content of some plant materials have also been studied in several investigations Adewuyi et al. (2017) and there have been previous studies on the analyses of extracts from ashes. Many of these researchers showed that the extract was chiefly potassium hydroxide with some quantities of sodium hydroxide. However, very few studies have focused on recovery of potassium.

Nigerian local and industrial agriculture relies on continual use of imported and non-renewable potassium supply, relatively, potassium hydroxide and potassium carbonate used for soap production (Afran, 2015). The consequences of relying on imported potassium include drain on foreign reserve and insufficient supply due to high capital requirements for the farmers, which renders its inputs into farms unaffordable. In addition, agro-forestry wastes are continually been generated from agricultural activities that are still largely under-utilized and left to rot on the field, there causing causes chronic environmental and health problems. Through the experimental determination, potassium recovery potential from various agro-forestry waste ashes, Nigeria could drastically reduce her importation of potassium and also generate wealth. The broad objective of this study was therefore to evaluate the recoverable potassium potential of selected agro-forestry and other very common organic wastes generated in Nigeria.

Potassium is a soft silvery-white alkali metal that oxidizes rapidly in air and is highly reactive with water. Potassium ion is essential for the functioning of all living cells; it assists in muscle contraction and in body metabolism. Potassium levels in the body also affect the functioning of the heart (Adewuyi et al., 2017). Experimental studies indicated that taking high potassium diets decrease calcium excretion and lowers blood pressure (Afrane, 2015). Potassium metal is very difficult to obtain from its minerals as it is extremely electro positive. However, it is available abundantly in nature as ionic salt. Plant cells, vegetables and fruits are the rich sources of natural potassium and about 22 to 75% of potassium present in these sources is extractable (AOAC, 2015).

Researchers investigated the feasibility of using various materials as raw materials for extraction of potassium, such as mango leaves, sorghum Sudan grass, sandstone, phosphate rock, vegetables, water hyacinth, orange peel, bentonite clay, bamboo dust, coconut shell and wheat bran (Ayeni et al., 2011). Many of these materials are not economical and not effective in the production of potassium, therefore, these methods are not suitable for recovering potash for the industrial uses because of technical and/or economical consideration. Thus, there is a need to develop a relatively cheaper and more effective sources.

Plantain fiber is a lignocelluloses material, relatively inexpensive and abundantly available. It is used as insulating material in construction and reinforcing due to its good compatibility and bonding with resin matrix the fiber prepared from banana pseudo stem has long been used in high quality textiles, shelter, tools and flower garlands (Babayemi et al., 2010). Banana pseudo-stem fibers are used in the preparation of sodium carboxyl methyl cellulose and cellulose micro fibrils. Banana pseudo stem fibers also used as resins in ion exchange. Banana leaves are also used as ecologically friendly disposable food containers such as "plates". Studies show that banana peel and pith have very high capacity to remove heavy metals and dyes from wastewater. Banana pseudo stem was also used in the production of alcohol and methane (Adewuyi et al., 2017).

The coconut palm, Cocos nucifera, is a member of the family Arecaceae (palm family). It is the only accepted species in the genus Cocos (Akrah,, 2017).The husks and leaves can be used as material to make a variety of products for furnishing and decorating. It also has cultural and religious significance in many societies that use it. The husk and shells can be used for fuel and are a source of charcoal. Activated carbon manufactured from coconut shell is considered superior to those obtained from other sources, mainly because of small microspores structure which renders it more effective for the absorption of gas and vapor and for the removal of color, oxidants, impurities and odor of compounds (Chowdhury et al., 2016).

Coconut husk uses are primarily based around enriching potting soil or providing an effective ground covering around small plants in a garden setting (Afrane, 2015). Coconuts can be harvested from the ground once they have ripened and fallen or they can be harvested while still on the tree. In most developing countries, the coconut husk is basically a throwaway material. It has been discovered that coconut husks fibers have good mechanical properties for composites used by many consumer-oriented companies. The coconut husk, also known as coir has become a very useful substance in light of today's environmental and economic concerns (Tan et al., 2008) and it has some common uses.

Having x-rayed the significance of potash, this work therefore focused on the leaching of potash from agricultural wastes such as coconut husk, plantain peel and cocoa pod husk for the possibility of soap making.

II. MATERIALS AND METHODS

2.1. Materials

Plantain peel, cocoa pod husk, coconut husk, Hydrochloric acid, Distilled Water, Methyl orange, Barium Chloride, Muffle Furnace (Model: KFL product 768), Oven (Model: 131015 Iowa, USA) maximum temperature of 500 ^oC, pH Meter, Electronic weighing balance (Model: Moittler Toledo K H 42 S), Magnetic Stirrer (Model: IKA C -MAGHS4, 250 rpm), UV Spectrophotometer (Model IBA 114, UK), Atomic Absorption Spectrophotometer (AAS S2 Model: Thermo elecHntron), Sieve, Beaker (250 ml), Pipette (5 ml), Sample bottles, measuring cylinder (100 ml), Retort stand, Pestle and mortal, Stirring Rod, Volumetric flask (100 ml), Burette (50 ml), Round bottom flask, Spatula and Filter paper.

2.2. Preparation of Samples

In the preparation of the samples, the method used by Adewuyi et al. (2017) was adopted with slight modification. The plantain peel, coconut husk and cocoa pod husks were sun dried for seven days to remove moisture and later dried in an oven at 100 ^oC for 48 hours. Those agricultural wastes were thus bone-dried, and the charred wastes were measured (M_1) and placed in a porcelain crucible before loading into a Muffle furnace (Model KFL product 768) at 500 ^oC. The ash samples were homogenized by crushing in a mortar and then sieved to 600 mic, 200 mic and 150 mic respectively. Meanwhile, the weight after drying was measured as M_2

2.3. Leaching of Potassium

A known weight of each of these ash samples was measured using weighing balance (Moittler Toledo) and placed on a round-bottom flask (250 ml). 30 ml of distilled water was added and thoroughly mixed before placing on a hot plate with magnetic stirrer (Model: IKA C-MAG HS4), kept under continuous stirring and heating at constant temperature of 100 ^oC for 30 minutes; agitation speed ranging from 60, 100, 120 and 150 rotations per minutes (r.m.p.), after which the flask was allowed to cool for 24 hours. The solution was then filtered using filter paper of 125 cm to obtain clear extract. The extract was further extracted under the same condition to obtain purer extract. A known weight (2 g) of the ash of each variety was dissolved in 25 cm^3 of distilled water. The solution was thoroughly shaken and allowed to settle for 30 minutes. 25 cm^3 of the clear portion was pipetted and titrated against 0.1 M Hydrochloric acid using methyl orange as indicator.

2.3.1 Elemental Analysis

The extracts of each sample were subjected to elemental analysis using Atomic Absorption Spectrophotometer (AAS S2 Model: Thermo elecHntron).

2.3.2 Determination of Potash Concentration and Absorbance

The concentration of potash was determined using UV Spectrophotometer. This was achieved by substituting the relevant concentration formula into the titre values obtained during titration of acid against alkali obtained at different temperatures, and other relevant constants of potash (i.e. molecular weight of potash).

2.3.3 Determination of pH

The pH values of the extracts were determined using 210 Microprocessor pH meter. The pH meter was calibrated using buffer solutions of pH 4, 7 and 9 respectively.

2.3.4 Moisture Content (MC) and Dry Matter Content (DM)

The moisture content of each sample was determined using the method suggested by Miroslav and Vladimir (1999):

$$MC = \frac{(M1 - M2)}{M1} \times 100 \qquad (1)$$

Where M_1 = Initial weight, and M_2 = Weight after drying. Likewise, the dry matter content was defined by Vladimir (1999) as follows:

$$DM = \frac{M2}{M1} \times 100 \qquad (2)$$

2.3.5 Ash Content (AC)

A known weight (M_3) of each oven-dried sample was placed in a crucible and loaded into Muffle furnace (Model: KFL product 768) set at 500 ^oC for 2 hours. It was then cooled and placed in a desiccator. The final weight (M_4) was determined using electronic balance (Mottler Toledo 4/156 – 66 - 70. 002). The ash content was calculated using equation 3 below:

$$AC = \frac{M4}{M3} \times 100$$

III. RESULTS AND DISCUSSION

The results of the leaching operations are represented in Figures 1 – 3:

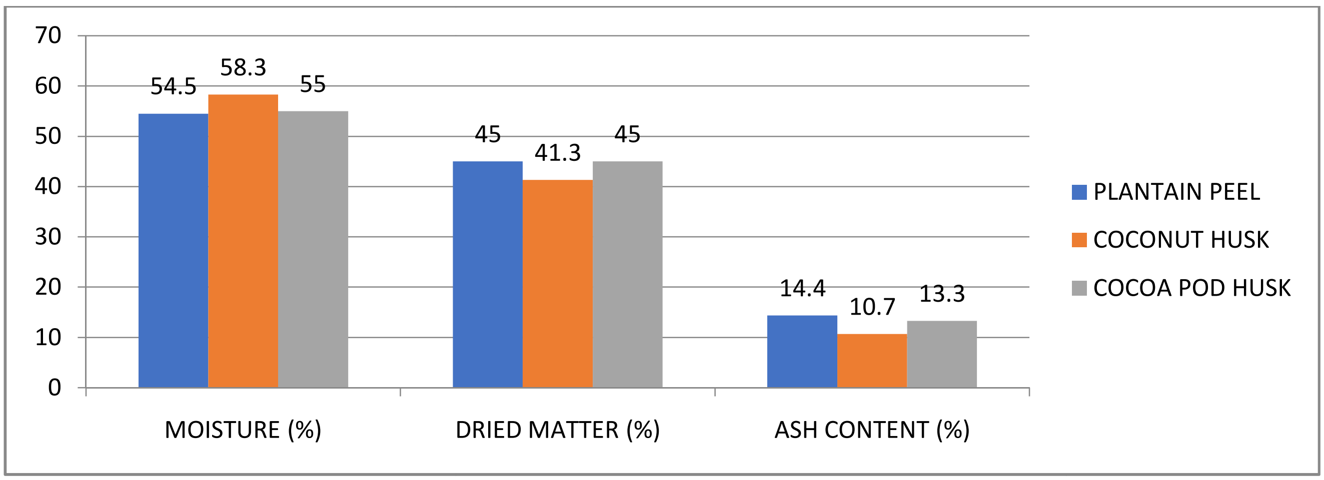

Figure 3.1: Percentage Moisture Content, Dried Matter and Ash content of the Samples

3.2 Elemental Analysis

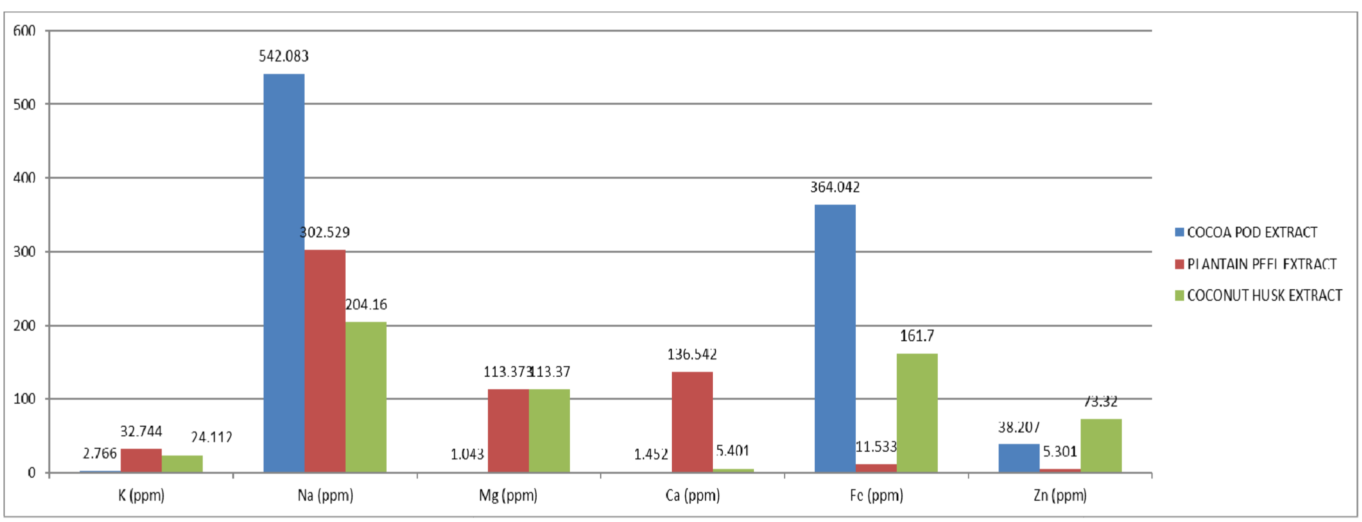

Figure 3.2: Amount of Minerals in Cocoa Pod, Plantain Peel and Coconut Husk Extracts (ppm)

The results of the analysis carried out revealed that the following elements were present in the samples: Potassium (K), Sodium (Na), Magnesium (Mg), Calcium (Ca), Iron (Fe) and Zinc (Zn).

Comparing the extracts from the three agricultural wastes analyzed in this study, the results revealed that:

i. For cocoa pod extract, Sodium (Na) has the highest value of 542.083 ppm elemental composition, followed by Iron (Fe): 364.052 ppm, Zin (Zn): 38.207 ppm, Potassium (K): 27.766 ppm, Calcium (Ca): 1.452 ppm and Magnesium (Mg): 1.043ppm.

ii. For plantain peel extract, Na has the highest value of 302.592 ppm elemental composition, followed by Ca: 136.542 ppm, Mg: 113.372 ppm, K: 37.744 ppm, Fe: 11.533 ppm and Zn: 5.301 ppm

iii. For coconut husk extract, Na has the highest value of 204.106 ppm elemental composition, followed by Fe: 161.700 ppm, Mg: 113.370 ppm, Zn: 73.302 ppm, K: 24.116 ppm and Ca: 5.401 ppm

3.3 Determination of Potash Absorbance

The determination of potash absorbance was carried out at a constant concentration and at varying of Temperature points and pH values, the results obtained are represented by Figures 3.3a and 3.3b.

From Figure 3.3a, the result of the absorbance of the three samples at 420 nm with varying temperatures reveal that the higher the temperature the higher the rate of the absorbance that is the absorbance rate increases gradually with an increase in temperature. At 60 ^{o}C the absorbance for plantain peel extract was 0.1038, 0.1105 for cocoa pod extract and 0.0632 for coconut husk extract. From the three samples the absorbance of plantain peel extract increases slightly as the temperature increases respectively. Among the three samples it was observed that plantain peel has the highest value of absorbance 0.3579 at the temperature of 110 ^{o}C this was followed by cocoa pod husk, 0.2087 and coconut husk has the least value of absorbance at 110 ^{o}C.

Figure 3.3b showed the results of the extract of absorbance at 420 nm of plantain peel, cocoa pod and coconut husk with varying pH.

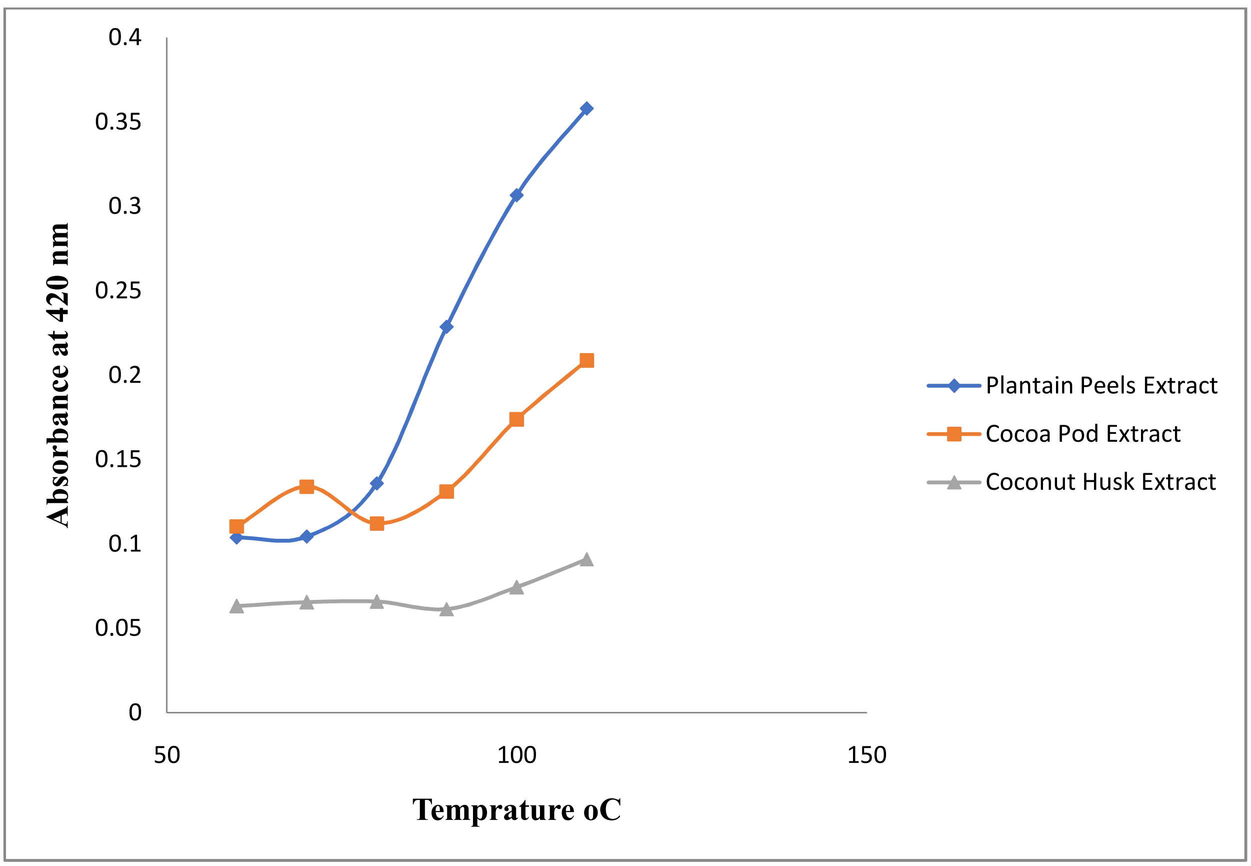

Figure 3.3a: Absorbance at 420 nm of the Extracts against Temperature (^{o}C)

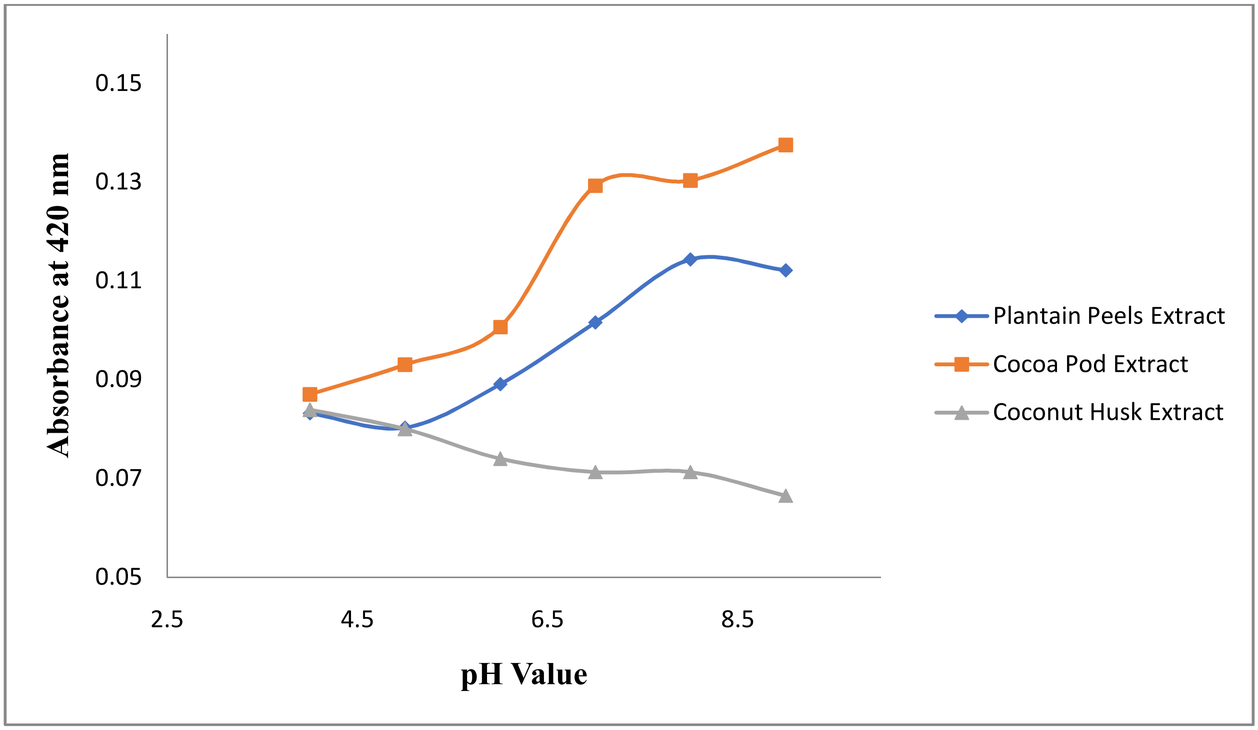

Figure 3.3b: Absorbance at 420 nm of the Extracts against pH

IV. CONCLUSION

Agro-forestry wastes are continuously being generated from agricultural activities that are still largely under-utilized and left to rot the field, which causes chronic environmental and health problems. Through the recovery of Potassium from various agro forestry waste ashes, Nigeria could drastically reduce her importation of potassium and also generate wealth. In this research work, the aim of was to extract potash from three agricultural wastes namely: coconut husk, plantain peel and cocoa pod husk. The potash was extracted from wastes using water and the extracts were titrated against 1.0 M HCl using methyl orange as indicator. The concentration of potash was determined using UV Spectrophotometer. The results showed that sodium in the extracts from cocoa pod, plantain peel and coconut husk were 542.083 ppm, 302.592 ppm and 204.16 ppm respectively. The agricultural wastes used are suitable for use in the extraction of potassium for soap making and environmentally friendly.

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