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Extraction and Isolation of Palm Husk Ash for Determinations of Potassium and Sodium Ratio

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Abstract

The purpose of the study was to extract crystal of alkalis from palm husk; quantify the alkalis contents of the ashes; and to determine potassium-sodium ratio using flame photometer.

Results from the preliminary treatment showed that the Moisture content (MC) was 6.41%, Ash Content AC 58.19%, Loss in Weight (LW) 41.81%, Alkali Content (AKC) 5.56%, %Residue was 93.21%, and efficiency of crystallization was 81.94%. The analysis of the alkali ion conc. of CO_3^{2-} and HCO_3^- potassium to sodium ratio was 13:1 and 1:234 for flame photometer result.

Keywords: Palm husk, CO_3^{2-} sequential titration. Alkali ions, potassium, sodium.

Introduction

Palm oil is one of the fastest growing sectors globally.The oil palm is a tall-stemmed tree which belongs to palm family *palmea.* [5].The countries in the equatorial belt that cultivate oil palm are Benin republic, Colombia, Ecuador, Nigeria, Zaire, Malaysia and Indonesia of which Malaysia is the largest producer of palm oil products [6].

Palm husk is one of the by-products left in the palm oil mill, this residue may cause environmental pollution problems and spread diseases, the commercial use of palm husk is still very low but local methods of utilizing palm husk residues will often produce ashes. An ash is a by-product of combustion obtained primarily from open burning (Incineration) of combustible materials such as fruit bunches, wood plant and synthetic products [3].The filtrate (palm bunch ash extract) obtained from the filtration of the mixture of palm husk ash and water has a brown colour and can emulsify oil. When these materials are burnt in air, the ashes contain oxides of potassium and sodium which when dissolved in water yields the corresponding hydroxides [7]

Materials and Methods

➢ Collection and preparation of materials

Palm husks were collected from Okitipupa and FUTA farm, Ondo State. Thereafter, the samples were sundried for one week and it were brought to the laboratory, Department of Chemistry, Federal University of Technology, Akure. The sample were communited in order for it to pass through the chamber of the in- house furnace at 650^{o}C. The ash were collected and stored in an air tight container at room temperature and portions were taken for further analysis.

➢ Preliminary treatment of the palm husk ash

The samples of the palm husk ash were sundried for six hours by mixing the ashes constituently for even drying. The weight of the ash was taken at every hour until approximately constant weight was obtained which indicted the substantial dryness of the samples.

The moisture content of the palm husk ash was determined based with the formular below;

$$\% \text{ MC} = \frac{W1-W2}{W1} \times \frac{100}{1} \quad \ldots\ldots\ldots\ldots (1)$$

Where % MC = percentage of the moisture content of palm husk ask residue sample

W_1 = Weight of palm husk ash before drying

W_2 = Weight of palm husk ash after drying

➢ Particle size distribution of palm husk ash

The particle sizing was done using the available sieves mounted on a laboratory sieve shaker for 15 min. The particle size in the range 212um < X < 38um with the largest proportion of the sample was selected for further experiments.

$$\% \text{ AC} = \% \text{ MC} = \frac{W3}{W2} \times \frac{100}{1} \quad \ldots\ldots\ldots\ldots (2)$$

Where AC = Ash Content

W_3 = Weight in grams of dried palm husk ash

W_2 = Weight in grams of the sieved fine powdery ash particles

The saturated solutions of the aqueous ash extract were prepared using the sieve powdery ash particle using a filtration process and the pH of the extract aqueous liquid was determined using universal litmus paper which was 12 at 32.3^{o}C indicating its alkalinity. The filtrate was considered aqueous alkali because all carbonates with the exception of those alkali metal and ammonium are insoluble in water. There was no evolution of ammonia gas and this tells us that ammonium is not present.

➢ Extraction and crystallization of the alkali crystal

The extracted filtrate was concentrated for 2 hours at the temperature of 70-80^{o}C on hot plate, the volume amount of alkalis recovered were measured, and it was to cool for crystals to form, but there was no crystals formed within the average 3 hours and so it was covered with was glass for 72hours before crystals was seen.The weight of the crystals was weighed, the crystals has brown colour due to impurities.

➢ Recrystallization and drying

Recrystallization was done on the impure crystals by adding hot distilled water (80^{o}C), after 48hours crystals was found on the bottom of the beaker. The recrystallization was done three times before a white crystals and a colourless filtrate could be obtained indicating that the crystals are free from impurities.The pH of filtrate was checked which amount to pH 10,then the filtrate was filtered through ashless fluted filter paper.

The slurry crystals were carefully poured into a clean glass crucible and it was placed inside the drying oven for heating at 105^{o}C for one hour. The crystals were transferred to a dessicator for cooling. After cooling the crystals, it was pour into a sample bottle to avoid decomposition of the product.

Percentage Alkali content (AKC) of the sample was estimated using this formular

$$\%\ \text{Alkali content (AKC)} = \frac{Weight\ of\ dried\ crystals}{Weight\ of\ sample\ taken} \times \frac{100}{1} \quad \text{...} (3)$$

➢ Determination of alkali ions concentration by sequential

The actual concentration of the alkali present in the solid crystal sample were measured based on the following chemistry; using a titrimetric procedure

$$OH- + HCl- \longrightarrow Cl^{-} + H_2O \quad \text{...} (4)$$

$$CO_3^{-} + HClCl^{-} + \longrightarrow HCO_3^{-} \quad \text{...} (5)$$

$$HCO_3- + HClCl^{-} + \longrightarrow H_2CO_3 \quad \text{...} (6)$$

Also, the aqueous alkali chloride solution was prepared using the following equations

$$MOH_{(aq)} + M_2CO_{3(aq)} + HCO_3^{-}{}_{(aq)} + 3HCl_{(aq)} \longrightarrow 3MCl + H_2O_{(l)}\ CO_{2\ (g)} \quad \text{...} (7)$$

$$3MCl_{(aq)} + H_2O_{(l)}\ CO_{2\ (g)} \longrightarrow MCl_{(s)} \quad \text{...} (8)$$

$$MCl_{(s)} \xrightarrow{\Delta} M^{+}{}_{(aq)} + Cl^{-} \quad \text{...} (9)$$

Where M is an Alkali metal. This indicated that all the chemicals have been converted to chloride salts.

➢ Determination of potassium and sodium ratio in the chloride mixture

Mohr's method adapted from Vogel qualitative inorganic analysis was usedto determine the chloride ions which were done by Argentometry method while flame photometer was used for the potassium and sodium ratio determination.

Result and Discussion

The physical parameters of the palm hush ash produced through an in-house furnace showed in table 1 below indicated the moisture content was determined as 6.41%, this shows that the moisture content of the ash was very low. This can be attributed to the charring conditions in which the palm husk was subjected to during ashing. It indicates that the temperature of furnace applied which is $650^{O}C$ invariably affects the Moisture content, thus reducing the level of water during the process of heating. This value does not agree with the moisture content reported by [2] for African wood species. This might be due to the nature of the palm oil which reflects in its moisture content.

The ash content reported as 58.1%. This value was higher than the value reported by [8] that range from 10.54% to 18.20% for various agro-wastes. The results showed the distinct nature of palm husk ash. From the results of the physical parameters, one may infer that residues share similar characteristics with other agro waste biomass [10].

The alkali content was determined as 5.67%. This agrees with the value obtained by [1] which ranged from 4.50 to 96.50% for various agro-wastes.

The high levels of mineral elements assayed in the palm husk ash extract from this study imply that this extract has high potential to enrich plant growth medium nutrients, and therefore, can support plant growth and development.

Table 1.The physical parameters of palm husk ash

Parameters	Values (%)
Moisture content MC	6.41
Ash Content AC	58.19
Loss in weight LW	41.81
Alkali Content AKC	5.56
Residue	93.21
Efficiency of Crystallization	81.94

The actual concentrations of the alkali in the palm husk -ash extract were measured using double indicator titration method, wherein 0.1HCl was titrated against a diluted solution of powdery crystals; the endpoint volumes of HCl in the first and second titration were respectively 14.15ml, and 24.70ml as shown in table 2.0 below.

Since the second step titre value was greater than the first titre value, we can infer that it may likely contain carbonates and bicarbonates. Also, the results of the endpoint volume of acid for titration in relation to the potash-alkali concentration were confirmed by the works of [4] and [9]

where in the analysis of different wood ashes and agro-waste biomass shared high concentration of potassium.

The moles of potassium and sodium was calculated qualitatively from the weight of crystal recovered which are K = 0.0843mol and Na = 0.0028mol respectively, potassium is more than sodium from the calculation of the moles of NaCl and KCl.

Table 2.The average titre value and alkali ions concentration of the palm husk by sequential titration method

Parameters	Value
Average titre value of HCl for OH^- and CO_3^{2-} neutralization (V_1) ml	**14.15**
Average titre value of HCl for HCO_3^-	**24.70**
ALKALI IONS CONCENTRATION	
OH^-Concentration, Mol/dm^3	**0.148**
CO_3^{2-} Concentration, Mol/dm^3	**0.246**
HCO_3^- Concentration, Mol/dm^3	**0.098**

From table 3.0 the potassium and sodium ratio was approximately 13:1. This showed that the palm husk ash and alkali crystals contain good amount of potassium as compared to sodium.

Table 3.Flame Photometric Analysis of the Samples

S/N	Sample code	NA(ppm)	K(ppm)
1	Blank	2.80	2.00
2	Sample	5.20	570.00

Conclusion

The research work has shown that, from the sequential titration carried out on the sample, it is evident that the ash content contains carbonates and bicarbonates. The argentometric titration helps to the fact that potassium was present in ash content and sodium was negligible.

So, we can infer that the sample contains potassium carbonates and potassium bicarbonates.

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