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Comparative Analysis of Alkali, Ash and Moisture Content of Some Agricultural Wastes

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Research Article

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Abstract

Comparative analysis of alkali, moisture and ash contents of some agricultural wastes which include palm bunch, plantain peel, banana leaf and maize cob were carried out to assess their usefulness in food, chemical and soap industries and as well as the possibility of reducing environmental pollution caused by them. Standard methods of analysis were used for all the parameters and the results revealed that all the wastes contain considerable amount of alkali in (g/l) as follows 0.05, 0.062, 0.016 and 0.03 and their molarity in mol/dm3 as 0.134, 0.09, 0.086 and 0.038 for Palm bunch, Plantain peel, Banana leaf and Maize cob respectively. The percentage ash content results were 2.91, 1.62, 2.02 and 1.12 while moisture content results were 53.77, 86.95, 79.05, and 38.54 respectively. The results suggested that some of the waste can be used for several beneficial purposes thereby reducing the harm and pollution they caused to the environment.

Keywords: Agricultural Waste; Alkali Content; Molarity; Ash Content and Soap Production

Introduction

Agricultural wastes have become an increasing concern in recent years, as they may cause significant environmental problems, however, they may also be used for several beneficial purposes, as feed stock for energy production and as raw materials in industries or chemical recovery and chemical or dye adsorption [1]. The pressure on the use of alkali in laboratories and for soap production has resulted in its exorbitant price, several agricultural wastes are littered all over the environment and accumulation of these wastes poses a serious health hazard. Apart from being an eye sore, even their proper disposal is a waste of resources causing significant environmental problems; however, they may also be used for several beneficial purposes, as sources of raw materials needed in soap making and food production. Therefore, such agricultural wastes could be converted to potash and used for soap making and other meaningful things. Alkali is sourced from various agro-wastes materials of vegetable origin. They have shown to yield high potash when combusted [2]. Traditional folks who major in the production of potash as a trade, especially for the production of local soap, either collect the ashes from wood industries where mixed sawdust of various species of wood as a waste is combusted, or from houses as domestic ash-waste from combustion of firewood. It is very important to know that the plant materials determine the potash yield. The process of combustion also contributes to the quality and quantity of ashes and consequently the quality and quantity of potash. When the vegetable materials are combusted slowly and at low temperature, the materials are not totally combusted to ashes, some black particles and some particles not combusted at all may be observed. These may impart colour to the extracted potash. Hence, most potash produced traditionally is usually coloured brown. To show an improvement in combustion, some experts have used special combustion pan, however, combustion in a temperature controlled furnace could give the best result [3]. Bio-alkali is the alkali derived from the ashes of burnt bio materials. Agricultural materials contain a good percentage of mineral salts. These include Calcium, Phosphorus, Iron, Sodium, and Potassium etc. When these materials are burnt in air, Carbohydrates, Fats, Proteins and Vitamins will all burn away and the resulting ashes contain oxides of these minerals. Some of these are corresponding hydroxides (alkali) [4]. Alkali can be defined as a base that dissolves in water to give hydroxide ions. It can also be referred as a soluble base, usually hydroxide or carbonate of potassium or sodium. Locally, it could be produced from ashes by extraction with water [5]. This research aimed at investigating the suitability of different agricultural waste as sources of alkali and ash, comparing their yields by quantifying some of their physiochemical parameters, and investigates ways of making these agricultural waste useful thereby reducing pollution.

Materials and Methods

Collection of Samples

The palm bunch and banana leaf waste were collected from a farm at Uratta Owerri North LGA while the plantain peels and maize cobs were collected from a home at Aladinma in Owerri Municipal Council both in Imo State. The samples were weighed before sun drying and then oven dried.

Determination of Moisture Content

Gravimetric method was used. 5g of fresh samples of the waste were weighed into a previously weighed moisture can and dried in the oven at 105^{0}C for 3 hours in the first instance. It was cooled in a desiccator and weighed. It was then returned to the oven for further drying. The drying sample was weighed at hourly interval until a constant weight was obtained [6]. The weight of moisture loss was obtained by the difference and expressed as a percentage of sample analyzed using the formula below.

$$\frac{(W_2\text{-}W_3)\ X\ 100}{W_2\text{-}W_1}$$

Where W_1= weight of empty moisture can
W_2= weight of can+ sample before drying
W_3= weight of can + sample after drying

Determination of Ash Content

This was carried out by furnace incineration, 5g of each samples was put in a previously weighed porcelain crucible. The sample in the crucible was burnt in a muffle furnace at 550^{0}C until it became gray (ash) after 3 hours. The furnace was allowed to cool to about 100^{0}C before sample was carefully removed and placed into the desiccator to cool. When cooled, it was reweighed and the weight of ash was obtained by the difference [6]. This was expressed as a percentage of the weight given by the formula below.

$$\%\ ash = \frac{W_2\text{-}\ W_1\ X\ 100}{W}$$

W= Weight of sample
W_1= weight of empty vessel
W_2= weight of crucible + ash

Extraction of Alkali from the Agricultural Waste

The collected palm bunch wastes were sun dried and later oven-dried at a temperature of 105^0 C for two days to ensure adequate removal of moisture from the sample. Bunches were charred for 3h to ensure uniform combustion. The charred bunch was further burnt in a temperature controlled furnace set at a temperature above 550^{0}C for proper ashing which lasted for about 8h. The ashed sample was homogenized by crushing between fingers and then sieved with analytical sieve of mesh size 126 x 10^{-4} micron to obtain uniform particles size. About 300g of the ash was placed in a 3 litres round bottom flask and 2 litres of distilled water added. The flask was placed on an electric heating mantle and boiled continuously to about 100^0 C for 4 h. After which the flask was allowed to stand for 48h and the content was filtered using poplin cloth and re-filtered with Whatman filter paper of 125cm to obtain clearer extract. The filtrate was poured into a beaker, placed on an electric hot plate and concentrated by evaporating to almost dryness. The solid residue (alkali) obtained was dried and weighed. The extracted alkali was purified by subjecting it to series of recrystallization procedure until the melting point of the resulting white solid was sharp. The molarity of the pure alkali–extract was determined by titrating against 0.IM hydrochloric acid using phenolphthalein as indicator [6]. The above procedures were repeated for Banana leaf, plantain peel and maize cob.

Result and Discussion

The results of the analysis were recorded below (Table 1).

Parameters	A	B	C	D
Moisture content (%)	53.77	86.95	79.05	38.54
Ash Content (%)	2.91	1.62	2.02	1.12
Alkali Content (g/l)	0.05	0.062	0.016	0.03
Molarity (mol/dm^3)	0.134	0.09	0.086	0.038

A= Palm bunch. B= Plantain Peel. C= Banana Leaf. D= Maize cob.

Table 1: Results of the moisture, Ash and Alkali contents of the selected agricultural wastes and their molarity.

- **Chart Representing Moisture Content of Each Sample**

A=Palm bunch, B= Plantain peel, C= Banana Leaf, D=Maize cob

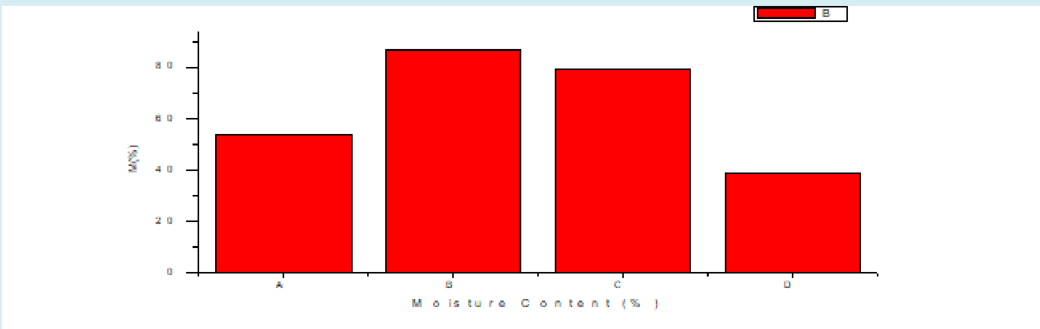

Figure 1: Percentage Moisture content of the samples.

From the chart Plantain peel have the highest moisture content followed by Banana leaf then Palm bunch and lastly Maize cob. Moisture content has been established as an important indicator of shelf life for foods. It can determine the aesthetics of food, giving estimates to product shelf life regardless of sample properties in wet or dry state. Moisture content is one of the most important characteristics in consumer sensory perception of food. It affect flavors and texture as well as physical and chemical properties, as water gives chemicals helpful medium to catalyze chemical reactions. The presence of free moisture is directly related to water activity, the higher the water activity, the more susceptible the food will be to interactions with microbes and its environment [7]. These result shows that plantain peel will spoil fastest because of high moisture content (Figure 1).

- **Chart Representing Ash Content of Each Sample**

Key A= Palm bunch; B= Plantain peel; C= Banana Leaf; D=Maize cob

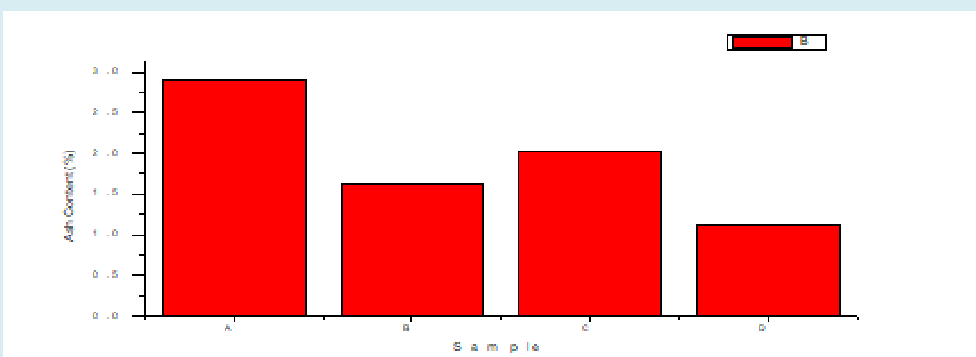

Figure 2: Percentage Ash content of the samples.

Ash content represents the total mineral content in foods. Ash is the inorganic residue remaining after either ignition or complete oxidation of organic matter in a food sample. Determining the ash content may be important for several reasons. It is a part of proximate analysis for nutritional evaluation. Ashing is the first step in preparing a food sample for specific elemental analysis. Because certain foods are high in particular minerals, ash content becomes important .From the chart Palm bunch have the highest ash content followed by Banana leaf, Plantain peel and maize cob. This show that palm bunch produces more ash compare to other sample. Ash content is essential to a food's nutrition and longevity as most of the ash content are mineral elements [8]. In this research palm bunch have the highest ash therefore may have more nutrients (Figure 2).

- **Chart Representing Alkali Content of Each Sample**

A= Palm bunch; B= Plantain peel; C= Banana Leaf; D=Maize cob

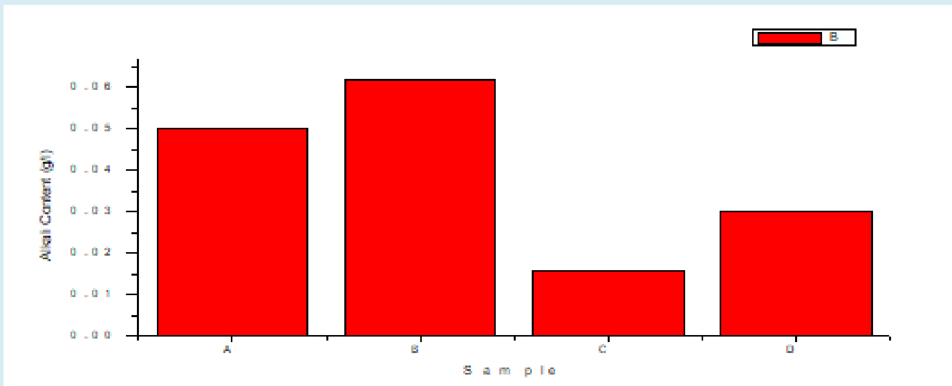

Figure 3: Alkali content of the samples.

From the chart Plantain peel has the highest alkali content followed by Palm bunch, Maize cob and Banana leaf. This show that Plantain peel produces more alkali compare to other agricultural waste sample studied. This may be the reason many people prefer using plantain peel and palm bunch for preparing local dishes. Research have shown that the soap made from alkali derived from plantain peel has the same colour as pure potassium hydroxide alkali soap and pure sodium hydroxide soap using the same blend of bleached palm oil and palm kernel oil [9]. Research has also showed that the improved soap produced with purified palm bunch ash-derived alkali was comparatively of a better quality than its conventional black soap counterpart considering some physio-chemical properties such as matter insoluble in water, matter insoluble in ethanol, unsaponified neutral fat and lathering characteristics of the soaps [6] and these may be as a result of its high alkali content. It have also been confirmed that the Palm bunch ashes can be used to produce neat solid soap which is of almost the same properties as pure potassium hydroxide soap [10]. Alkali can help soften potable water and remove impurities such as manganese, fluorides and organic tannins. According to the National Lime Association, heavy industries use alkali in the form of lime to adsorb and neutralize Sulphur oxides to aid in reducing acid rain. Alkalis can convert waste products by maintaining the correct pH for oxidation of sewage. Applying alkali can stabilize sewage sludge, and reduce odour or bacteria [11]. For industrial and mining operations, applying alkalis to wastewater can remove phosphorus and nitrogen and improve clarity. Excess alkalinity treatment raises the pH of water to 10.5 to 11 and can disinfect the water and remove heavy metals [11]. Alkaline detergents aid in hard surface cleaning. These economical water soluble alkalis with a pH from 9-12.5 can neutralize acids in different types of dirt and soil and can be used to increase the pH of water in water industries. Alkaline food promote health in endless way, it encourage the activity of osteoblast, more energy and stronger immune system, an alkaline body is connected to the benefits against chronic illness. One of the most well known claims of the alkaline diet is that it prevents or stops the growth of cancer and prevent osteoporosis making the body less susceptible to weight gain [12,13] these alkali gotten from these agricultural waste especially plantain peel and palm bunch can serve all these purposes [14] (Figure 3).

- **Chart Representing Molarity Of Each Sample**

Key A= Palm bunch; B= Plantain peel; C= Banana Leaf; D=Maize cob

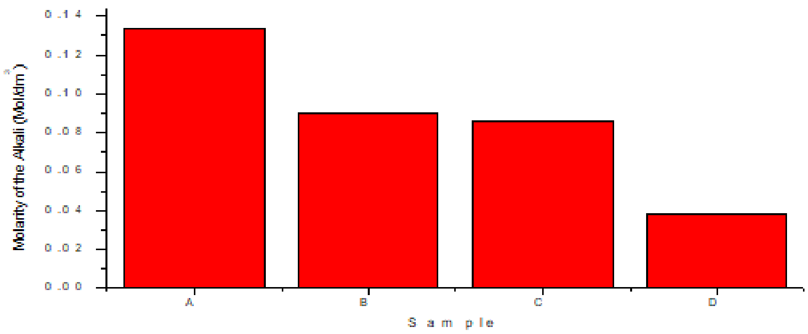

Figure 4: Molarity of the alkali in the samples.

From the chart Palm bunch have the highest molarity followed by Plantain peel, Banana leaf and Maize cob. This show that Palm bunch alkali has the highest molarity compare to other agricultural waste alkali. This may be the reason while many people prefer using palm bunch and plantain peel alkali for soap making (Figure 4).

Conclusion

Production of soap and preparation of some local delicacies with purified alkali made from Agricultural waste ash is an improvement over the conventional method adopted for black soap. The qualities of soaps thus produced clearly indicated that exploitation of vegetable matter to generate alkali for soap production is worthwhile. Apart from the fact that our environment would be free of those agricultural wastes that often render them untidy, it will save the environment from the potential harmful effects of pollution that commonly associate with these materials. In addition, the heavy-dependence on synthetic chemicals for soap production would drastically reduce if concerted effort is made on improving this source for soap making. The current local production of ash-derived alkali is an improvement that trailed the path of the ancient traditional technology. Local production is a cheap method which if well explored could meet the need of this chemical as raw material in industries.

Recommendation

Vegetable matter represents a potentially viable materials resource which if not properly harnessed, could actually harm the environment. It is therefore recommended that agricultural waste ashes should be used as alkali sources in soap production since it gives quality products. This will help to reduce the cost of raw materials, improve production and the economy of the country. It will also help in reduction of land and air pollution caused by these waste thereby making the environment conducive for the inhabitant.

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