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A Comparative Study of Elemental Compositions of Coconut Shell Powder and Coconut Coir Ash for Selective Applications

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ABSTRACT

This research is aimed at comparing the suitability of coconut shell powder with coconut coir ash as a filler material in automobile brake pads. The materials were gathered and cleaned. The shells were then pulverized by pounding and grinding. The coir was charred in a controlled environment. The particle grit size of the powder was determined using BS1377:1990. Both materials were then characterized using XRF technique. It was established that they can both be effectively used as filler materials in automobile brake pads.

Key words*: coconut shell, coconut coir, brake pad, automobile, materials, characterization.*

1.0 Introduction

The search for alternative materials for brake pad materials for automobile application has made renewable materials to become attractive candidates. Among these are agricultural produce and/or waste. The coconut tree has been known to be versatile for a number of applications. Often called a wonder plant, all parts of the tree find useful application in society, from the roots, through the trunk, the fruits, and leaves. On it can be obtained medicine, food, shelter and raw materials. Coconut trees can be found fairly all over the world. The coconut tree is aptly known as the "tree of life".

2.0 Background/Literature

Coconut is famous as a multi-function plant that all parts of its plant can be used for various applications, activities and products (Meyer, 2001). Its products are known to be suitable in a variety of applications .The use of coconut by-products has, in fact, been a long time source of income for some people in Oceania and other parts of the world. The coconut has many uses. The fruit itself is used in many industries not only as food but also for uses as lubrication oil, hair-treatment oil, and others. The energy industry has also seen the potential of the coconut as the coco-diesel was created as an alternative to the fossil fuel. Aside from its ornamental use, the shell has been powdered and used as glues and its charcoal form is used as activated carbon and applied as filter material for masks and air-conditioning systems. In the construction industry, the husk is used as a mat in preventing the erosion of soils. Particle boards are created from the husk of the coconut by acquiring the fibres from the husk, as well as mattresses and pole vault pads from the coconut fibre (Ganiron, 2013).

3.0 Methodology

Coconut shells were collected cleaned pounded and ground to powder form; the right particle size of 212µm was obtained using a set of particulate screens in accordance with BS1377:1990. Proximate analysis was carried out on the coconut powder with the results shown in Table 1. Characterization of the coconut shell powder and coir ash were carried out. Also characterized were Aluminium oxide, Calcium carbonate using X-Ray Fluorescence (XRF) machine, and X- Ray diffraction XRD, as well as epoxy resin using Fourier Transform Infra-red Refractory (FTIR) technique. The oxide analysis and elemental compositions of the Coconut Shells, Aluminium oxide, and Calcium carbonate was determined using X-Ray Fluorescence (XRF) machine, Mavern Model**,** while X-Ray Diffraction (XRD) was carried out to determine the crystalline phases present in the sample materials. The XRD machine also of Mavern Model was used. The characterization of Epoxy resin was carried out using Fourier Transform Infrared Spectroscopy (FTIR) machine, Model ATP 9110 Full - Range, high precision, with wavelength 300 – 2500nm**.** This was to observe the functional groups as well as the finger prints of the sample.

Results of XRF on the samples are shown in Tables 2 and 3, while figure 1 shows the XRD plot of the coconut powder.

4.0 Results

Table 1: Proximate Analysis of Coconut Shell Powder

Description	Nitrogen	Crude Fibre	Ether Extract	Ash Content	Moisture Content	Volatile Matter
% Composition	3.031	41.93	0.35	1.90	4.88	12.75

Table 2: Composition of Coconut Shell powder

Element	**Concentration (%)**	**Peak(cps/mA)**	**Background (spd/mA)**
Fe_2O_3	0.08014	921	-33
CuO	0.002636	86	14
NiO	0.0244	3	13
ZnO	0.001253	2	18
Al_2O_3	0.0195	1006	1401
MgO	0.2218	129	188
Na_2O	0.0649	8	28
S	0.0649	1083	1413
P_2O_5	0.11506	655	928
CaO	0.525	2150	-72
K_2O	0.2022	886	-50
MnO	0.002535	118	257
Rb_2O	0.001011	6	3
SrO	0.00381	25	3
Br	0.00123	3	3
Cl	0.02450	33	8
Cr_2O_3	0	0	97
V_2O_5	0.000281	14	42
Cellulose/Lignin	98.64		

Table 3: Composition of Coconut Coir Ash

Element	Concentration(%)	Peak (cps/mA)	Background (cps/mA)
Fe_2O_3	0.09692	1114	-49
CuO	0.000923	30	9
NiO	0.0352	4	5
ZnO	0.001385	80	5
Al_2O_3	0.15737	2200	1611
MgO	1.1821	688	266
Na_2O	0.170	20	175
S	0.24528	4123	243
P_2O_5	0.9633	5487	-575
CaO	0.5871	2401	2263
K_2O	6.8986	30238	-1139
MnO	0.000402	19	106
Rb_2O	0.01487	90	13
SrO	0.00795	53	2
Br	0.00883	20	5
Cellulose	89.2977		

The elemental composition of the coconut shell powder obtained from XRF shows the following percentages of inorganic elements present with the corresponding peaks: CaO (0.525%), MgO (0.2218%), K_2O (0.2022%), and P_2O_5 (0.11506) with the peaks in cycles per second (cps) of 2120, 129, 886 and 655 respectively while the rest are in trace amounts. The sample is predominantly lignocellulosic (98.64%). Furthermore the coconut shell has specific heat capacity of 18.40 J/kg; average thermal conductivity of 0.06 W/m K; Asbestos has 0.08 W/m K. It has apparent density of 0.6 to 0.98g/cc, and moisture content of 8% to 12%, ash content of 1.09%. Cazetta, *et al*., (2013). The characteristics of coconut shell powder and coconut coir ash are as shown in Tales 1 and 2 respectively.

In comparison, coconut coir ash has the following compositions and peaks: K_2O_2 has 6.896% and 30238 cps, MgO has 1.1821% and 1.1821cps, P_2O_5 has 0.9633% and 5487cps, CaO has 0.5871% and 2401cps, Sulfur has 0.24528% and 4123 cps, and NaO has 0.170 and 20 cps. In both cases the bulk of the material is essentially cellulose and lignin. This agrees with the work of Yerima and Grema (2018).

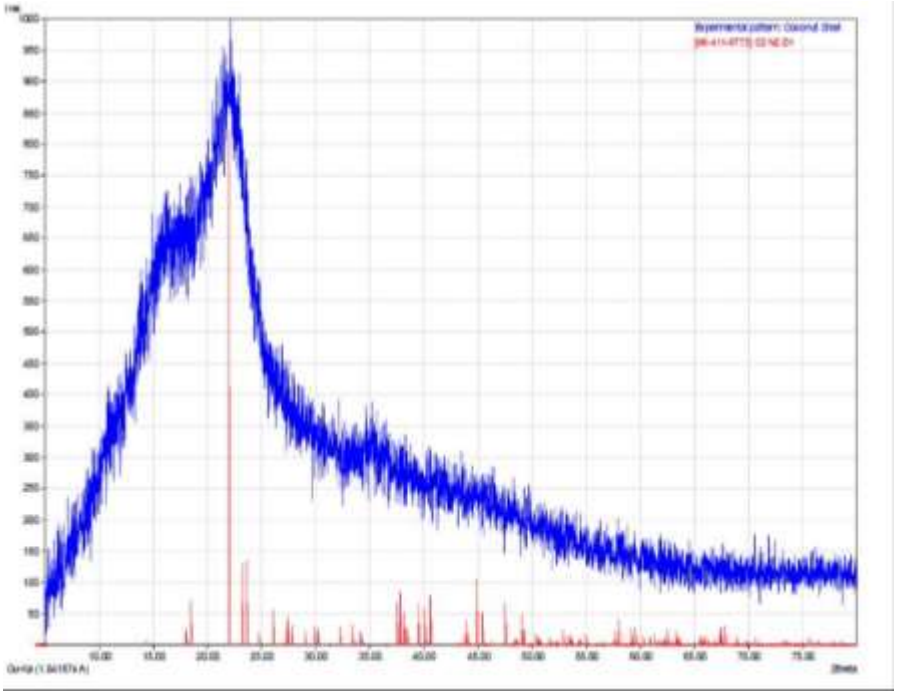

Fig. X: ***Diffraction Pattern Graphics for Coconut Shell Powder***

5.0 Conclusion

In conclusion, the elemental compositions of coconut shell powder and coconut coir ash show that both materials are suitable for a wide range of applications including automobile brake pads. It is not envisaged that the many uses of coconut will result in the scarcity of the raw material for brake pads, but will rather encourage more cultivation of the plant also ensuring zero wastage of any part of it thereof. This is good for the environment and the economy.

6.0 Recommendation

It is recommended that this materials ca e effective used as reinforcement for friction materials in rake pad application.

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Appendix

Plate I: Coconut Tree with Fruits

Plate II: Coconut Shells

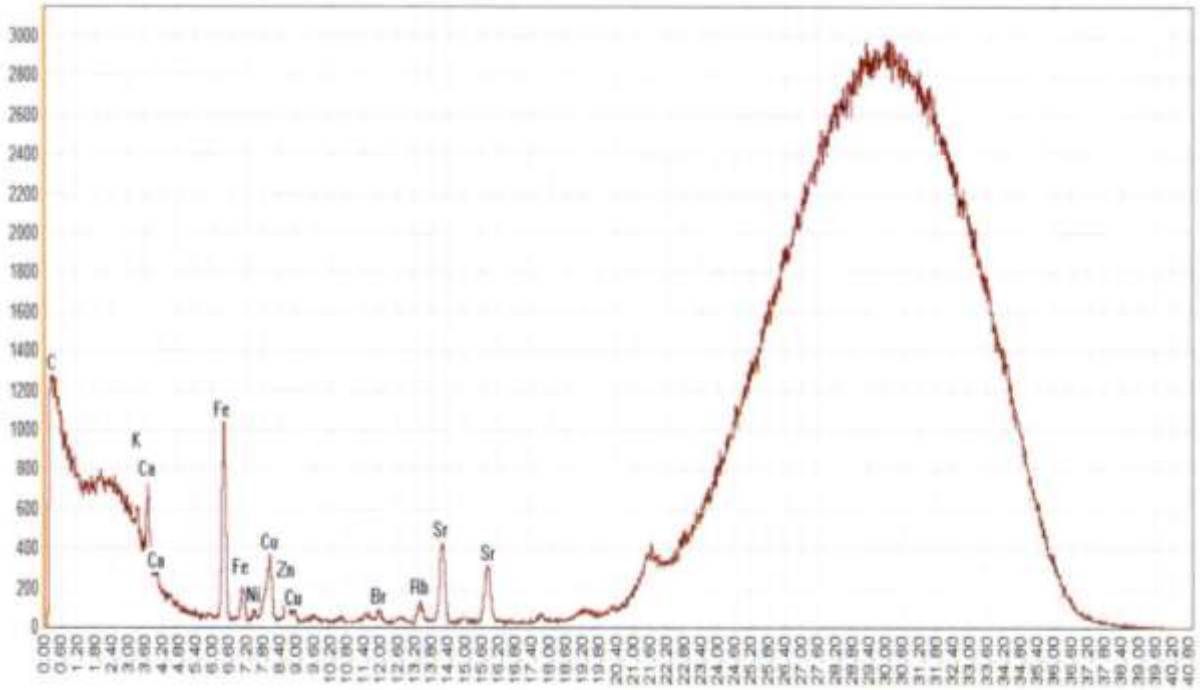
Plate III: Coconut Coir

Plate IV: Coconut Coir Fibre

Plate V: **Coconut Shell (crushed)**

Plate VI: Coconut Coir Ash

Plate VII: Coconut Shell Powder



Energy [keV] [Counts]

Fig. 2: *XRF Graphics of Coconut Shell Powder*

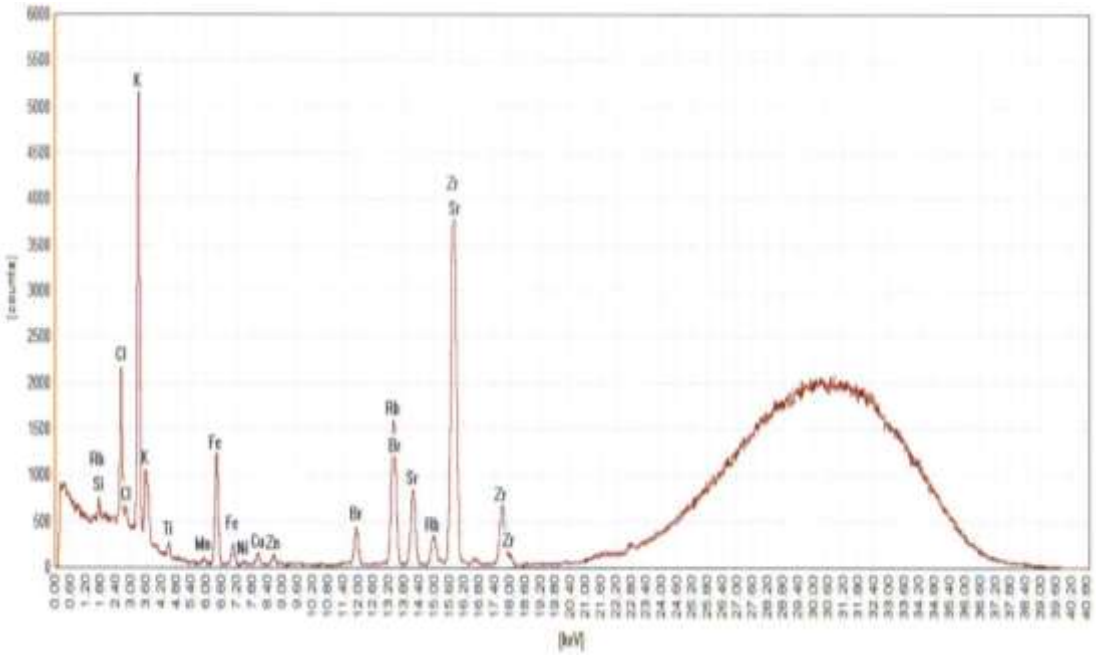


Fig.3: *XRF Graph of Coconut Coir Ash*