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Luffa Sponge, Banana Stem and *Delonix regia* Seed Characterization as Potential Biosorbents for Industrial Wastewater Remediation

Ephraim G. KEFAS[1*], Abdulfatai JIMOH[2], Mohammed A. EVUTI[3], Abubakar A. IBRAHIM[4], Abdulwahab GIWA[5], Adeola G. OLUGBENGA[6]

[1*,2,3,6]Department of Chemical Engineering, Faculty of Engineering, University of Abuja, Nigeria
[4]Department of Chemical and Petroleum Engineering, Faculty of Engineering, Bayero University, Kano, Nigeria
[5]Department of Chemical Engineering, Faculty of Engineering, Federal University Dutsin-Ma, Katsina State, Nigeria

[1*]kefasephraim3@gmail.com, [2]abdulfatai.jimoh@uniabuja.edu.ng, [3]mohammed.evuti@uniabuja.edu.ng, [4]aabrahim.cpe@buk.edu.ng, [5]agiwa@fudutsinma.edu.ng, [6]grace.olugbenga@uniabuja.edu.ng

Abstract

This paper focuses on characterizations of luffa sponge, banana stem and Delonix regia seed as potential resources for the development of biosorbents for heavy metals removal from industrial effluents. The selected materials were pretreated by washing, sun drying, and oven drying before being pulverized into powder. The powders were subjected to proximate, ultimate, chemical composition, SEM/EDX, FTIR, DTA/TGA and XRD analyses. Fixed carbon content ranges from 49.29±0.20%-52.34±0.02% for the samples. The carbon content values range from 65.27±0.01%-66.87±0.02%, and the Sulphur content ranges from 0.37±0.01%-0.81±0.001%. Cellulose content values of 41.64±0.002%, 40.86±0.001% and 45.24±0.001% were found for luffa sponge, banana stem and Delonix regia seed, respectively. SEM/EDX and FTIR confirm the presence of carbon, nitrogen, and potassium as the dominant elements, while OH^-, C=C, C=O, C-H, and N-H as the surface functional groups in the precursors. The DTA/TGA shows that rapid weight loss for luffa sponge, Banana stem, and Delonix regia seed occurs between 300-420°C, 290-350°C, and 280-480°C, respectively. XRD revealed that the precursors are largely amorphous/semi-crystalline, predominantly amorphous, and a mixture of amorphous and crystalline, respectively. The above findings show that the selected precursors would be good resource for use as adsorbents/blends for the removal of heavy metals from industrial effluents.

Keywords: *Biosorbent, characterization, effluents, heavy metals.*

1.0 Introduction

Characterization of materials is crucial to understand their properties, predict performance and optimized their applications. It provides the essential information on a material structure, surface chemistry, morphology and physical characteristics like surface area and pore size. This knowledge is vital for knowing what type of pollutants it can remove, how effective it will be and how to design or modify it for improved adsorption processes.

Given the significance of adsorption processes in numerous applications, particularly in water and wastewater treatment, the advancement and optimization of adsorbent materials remains a critical research focus. Comprehensive characterization of any newly developed adsorbent is essential to determine its properties, justify its intended use, and elucidate its performance within target processes. A range of physical and chemical information can be acquired through various analytical techniques, the selection of which is dependent upon both the material under investigation and available instrumentation. The available techniques include proximate/ultimate analysis, Ultraviolet (UV-vis), Fourier transform infra-red spectroscopy (FTIR), Scanning electron microscopy/Elemental analyzer (SEM /EDX), zeta potential, X-ray diffraction (XRD), surface area and porosimetry, thermo-analytical analysis (TGA/DTA) amongst several others [1]. These techniques help identify, locate, and measure chemical components—such as elements, functional groups, and molecules, and analyze physical properties like structure, morphology, magnetic traits, and size. This information supports evaluating adsorbent material synthesis and studying adsorption processes through adsorbent, adsorbate interactions.

In recent years, biosorption, which utilizes natural biological materials to sequester pollutants from aqueous solutions, has gained attention as an environmentally friendly and economically viable alternative [2]. These agricultural residues and plant-based materials are especially attractive due to their abundance, renewability, low cost, and the presence of functional groups such as hydroxyl, carboxyl, and amino groups that facilitate adsorption of contaminants [3]. The method of preparing and packaging of the precursors play a significant role in the final quality of the product [4]. The use of raw *Delonix regia* seed as a biosorbent from North western Nigeria for heavy metal removal has not been found in literature as at the time of this paper by authors. Therefore, the comparison

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of properties of luffa sponge, banana stem and *Delonix regia* seed, in their raw forms, for possible synergy, might be very useful as it has not been documented in literature.
The study aims to prepare and characterize luffa sponge, banana stem and *Delonix regia* seed to understand their properties and surface functionalities. By leveraging the complimentary properties of the individual components, the research seeks to develop an effective, low cost and suitable biosorbent capable of addressing the challenges of industrial wastewater remediation.

2.0 Materials and Methods

2.1 Materials (Sample Collection)

The precursors, luffa aegyptiaca sponge (LS), and *Delonix regia* seeds (DRS) wastes were sourced from the Tudun Wada campus of Kaduna Polytechnic (10.524227°N,7.419382°E) as they grow there wildly. Banana stem (BS) was sourced from a plantation in Tudun Wada Kaduna (10.521557°N, 7.415232°E).

2.2 Samples Preparation

The 3 precursors (LS, BS and DRS) were washed with clean water to remove surface impurities such as dirt. They were then sun-dried for 5 days. The sun-dried samples were then cut into smaller sizes, and oven (SANFA DHG9030) dried at 105 – 110 ±2°C for 2 hours. The dried samples were then removed from the oven and allowed to cool in a desiccator. After cooling, they were ground into powdered form using industrial grinder (Laboratory Disc pulverizer). The precursors (LS, DRS and BS) were then washed with distilled water, filtered and oven dried again. They were then sieved using micrometer (250-100 μm) sieves and stored in air-tight polythene bags, clearly labelled for each precursor, for further analysis to avoid mixed-ups.

2.3 Characterization of Precursors.

Powdered samples prepared in section 2.2 were subjected to various characterizations that include: - Proximate and Ultimate analysis, Fourier transform infra-red spectroscopy (FTIR), X-ray diffraction (XRD), (SEM/EDX), and (TG/DTA) detailed below: -

2.3.1 Proximate Analysis

The proximate analysis of the samples was determined according to ASTM D1762-84 method. The analyses include ash content, moisture content, fixed carbon and volatile matter.

Ash Content

The data of the proximate analysis of the samples were measured in triplicate. The ash content was determined using Equation (1),

$$\%Ash\ content = \frac{100\ (F - G)}{(B - G)} \quad (1)$$

where:
G = Mass of empty crucible (g)
B = Mass of crucible + sample (g) at 103°C
F = Mass of crucible+ ash sample (g) after heating at 730°C

Moisture Content

The moisture content was determined using Equation (2),

$$\%MC = \frac{100(B - F)}{(B - G)} \quad (2)$$

where:
MC = moisture content (%)
B = mass of crucible + original sample before heating (g)
F = mass of crucible + dried sample (g) after heating at 105°C
G = mass of crucible (g)
The same procedure is repeated for all the samples.

Volatile Matter

The volatile matter was then determined using Equation (3),

$$\%VM_{dry\ basis} = \frac{(B - C) * 100}{B} \quad (3)$$

where:
B =Air dried weight of sample (g)
C = Furnace calcined weight of sample (g) after heating at 850^{o}C

Fixed carbon

The percentage of Fixed carbon (*Fixed carbon, FC)* is determined by subtracting the percentages of volatile matter (*% volatile matter)* and ash content (*% ash content)* from 100. This value is typically estimated as the remainder after deducting all other constituents.

Fixed carbon FC = 100 – (% moisture content+ % volatile matter + % ash content). (4)

2.3.2 Ultimate Analysis

The ultimate analysis of the 3 precursors was carried out using LECO CHNS-2000 elemental analyzer.

2.3.3 Biochemical Properties Determination

Ash content: 0.2 g of the sample was placed in a porcelain crucible and heated in a muffle furnace to 600^{o}C for 3hours. The crucible was allowed to cool in the furnace to less than 100^{o}C and then placed in a desiccator with a vented top to cool. Then the mass of the residue was noted.

$$\% \, Ash = \frac{Mass\ of\ Ash\ Residue}{Mass\ of\ Sample}\ x\ 100 \quad (5)$$

Lignin content: 2 g of extracted sample were placed in a 100 ml beaker, treated dropwise with 20 ml of 72% sulfuric acid, and stirred until fully disintegrated. After standing overnight at room temperature under a watch glass, the mixture was transferred to a 1-liter flask, diluted to 3% sulfuric acid, and refluxed for four hours. Lignin was then filtered using ashless filter paper, washed with warm distilled water to neutrality, and gravimetrically measured as 'A'. It was then ignited at 850°C for 45 minutes, and the ash weight noted, B. The weight of ash is subtracted to give the ash-free lignin per cent.

$$\% \, lignin = \frac{A-B}{2} x100 = \frac{Mass\ of\ Residue}{Mass\ of\ Original\ Sample} x\ 100 \quad (6)$$

where: -
A = weight of linin + ash (g)
B = weight of Ash (g) after ignition at 850^{o}C

Hemicellulose Content: 3 g of sample (B) was placed in a 250 ml porcelain beaker. Add 25 ml of 17.5% NaOH, let swell for 4 minutes, then press with a glass rod for 3 minutes. Add another 25 ml NaOH and mix until homogeneous (about 1 minute). Cover and leave at 20°C for 35 minutes. Add 100 ml of 10% acetic acid dropwise to neutralize, forming a precipitate. Add 100 ml distilled water, filter under suction with a sintered glass funnel, and pour filtrate over the paste twice before rinsing with distilled water to neutrality. Dry the sample at 105°C until constant weight is achieved (C).

$$\% \, Hemicellulose = \frac{Mass\ of\ Neutralized\ Precipitate}{Mass\ of\ Original\ Sample} x100 \quad (7)$$

$$Cellulose = 100\% - (Hemicellulose + lignin + Ash + Starch) \quad . \quad (8)$$

2.4 Instrumentation

The phase composition and material structure (amorphous or crystalline) was determined using XRD machine RIGAKU, (model Miniflex 600-C) with 2θ ranging from 5^o – 70^o. The surface chemistry (functional groups) of the sample was determined using a Perkin Elmer Fourier-transform infrared (FTIR) spectrometer (spectrum 1) at wavenumber 4000 cm^{-1} – 650 cm^{-1}, resolution 8, and number of scans 32. The surface morphology/elemental composition determination of the sample was determined using a Hitachi scanning electron microscope (SEM, TM 3000 model) with accelerating voltage =15 kV, BSE detector, field width = 537µm, Intensity = map and magnification = x500. The thermal distribution of the sample was determined using a Perkin-Elmer Thermogravimetric Analyzer (TGA). 12.3 mg, of raw luffa sponge, raw banana stem and raw *Delonix regia* seed were heated from 30 – 950^{o}C at a heating rate of 10 ^{o}C/min. The results were then plotted graphically.

3.0 Results and Discussion

The results from the characterization of the 3 precursors from sub-sections 2.3 – 2.4 are as depicted in Tables 1- 4 and figures 1-10.

3.1 Proximate and Ultimate Analysis

Table 1 and 2 shows the results of Proximate and Ultimate analysis respectively for the 3 precursors, Luffa sponge, Banana stem and *Delonix regia* seed. The % carbon decreases in the order LS greater than DRS and DRS greater than Banana stem. Similar conclusions were documented by [6], [9] and [7]. The relative difference in the values of the parameters determined for the 3 samples and literature may be as a result of soil composition, maturity of plant at harvest time and processing techniques [7].

Table 1. Proximate analysis of precursors compared with previous works

Parameter/Material	Moisture Content (%)	Ash Content (%)	Volatile Matter (%)	Fixed Carbon (%)	
1. Luffa Sponge	3.30 ±0.2	2.16 ±0.5	42.20 ±0.09	52.34 ±0.2	Current work
	7.6 ±0.4	18.25 ±0.2	43.40 ±0.7	30.75 ±0.4	[5]
	-	-	-	-	[6]
2. Banana Stem	4.20 ±0.08	2.31 ±0.5	44.20 ±0.08	49.29 ±0.2	Current work
	-	2.1	73.3	24.54	[7]
	1.93±0.01	23.53±0.07	59.77±0.48	14.78±0.04	[8]
Delonix regia Seed	4.10 ±0.10	2.29 ±0.4	43.90 ±0.09	49.71 ±0.1	Current work
	5.26 ±0.06	1.86 ±0.06	92.54 ±0.15	0.34 ±0.083	[9]
	5.21	12.87	75.97	5.95	[10]

Table 2. Ultimate analysis of precursors compared with previous works

Elements/ Material	Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulphur (%)	Oxygen (%)	
1. Luffa Sponge	66.27±0.01	5.34± 0.0	19.10± 0.001	0.42±0.001	8.77±0.001	Current
	65.0 ±0.3	5.98 ±0.3	1.12 ±0.1	0.80 ±0.3	10.80 ±0.2	[5]
	48.0	5.8	-	-	42.2	[6]
2. Banana Stem	65.64±0.00	3.09±0.001	20.70± 0.001	0.30±0.002	10.27±0.001	Current
	35.96	6.82	0.88	0.08	56.26	[7]
	33.93±0.03	4.02±0.01	1.47±0.01	0.09±0.01	60.49±0.06	[8]
3. *Delonix regia* Seeds	65.87±0.002	2.87± 0.001	23.17± 0.001	0.81± 0.001	7.28± 0.002	Current
	40.67 ±0.59	6.44 ±0.02	-	2.14 ±0.11	-	[9]
	66.26	1.92	2.89	-	-	[10]

3.2 Biochemical Properties of Precursors

Table 3 presents the chemical composition of the 3 samples investigated. The cellulose content of the current work shows that DRS > LS > BS. Results obtained by **[12,13]**, **[7,8]** and **[9]** shows that the cellulose content of LS>BS>DRS respectively. The difference in some of the values may be due to the maturity stage at point of harvest, soil nature and processing step adulteration/equipment precision **[7,14]**.

Table 3: Chemical properties of luffa sponge, banana stem and *Delonix regia* seed

	Hemicellulose	Lignin	Ash	Starch	Cellulose	
1.Luffa Sponge	22.46 ±0.001	21.72±0.001	2.16±0.001	12.02±0.001	41.64±0.002	Current
	15.8±0.002	14.70±0.003	10.40±0.002	-	37.70±0.0466.78	[11]
	19.43	13.1	-	-	63.0±2.5	[12]
	20.88±1.4	11.60±1.2	0.40±0.1			[13]
2.Banana Stem	23.38±0.001	20.11±0.001	2.31±0.001	13.34±0.001	40.86±0.001	Current
	24.40	3.40	10.70	-	35.20	[7]
	17.5	37.3	-	-	44.0	[8]
3.*Delonix regia* Seeds	22.02±0.001	18.77±0.001	2.29±0.001	11.68±0.001	45.24±0.001	Current
	39.00 ±1.00	16.50 ±1.00	-	-	34.50 ±1.50	[9]

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3.3 XRD Analysis of the Precursors

Figure 1 depicts the result of X-ray diffraction analysis of Luffa sponge. The distance between adjacent crystal planes in this material was found to be 3.897 ± 0.006 Å with an average crystal size of 9.36 ± 0.11 Å. The sharp peak around ~22.81±0.03°, is characteristic of amorphous carbon (Chaoite) which is 20% of the structure, indicating that the material lacks a well-defined crystalline structure, similar result was obtained by [15]. The broad peak at 10 – 15° indicates highly disordered material. The sharp peaks may represent crystalline impurities including silicon oxide (SiO_2) 13%, epsomite ($MgSO_4 \cdot 7H_2O$) 11%, aluminum phosphate ($AlPO_4$) 16%, and marialite ($Na_{3.21}Ca_{0.68}K_{0.11}$) 2% [16]. The combination of amorphous and crystalline phases could enhance the adsorption or catalytic activity of the material, as amorphous structures offer high surface area and porosity, while crystalline phases contribute to specific chemical reactivity. This profile is consistent with materials used in water treatment, adsorption, or catalysis with inorganic additives as reported by [15].

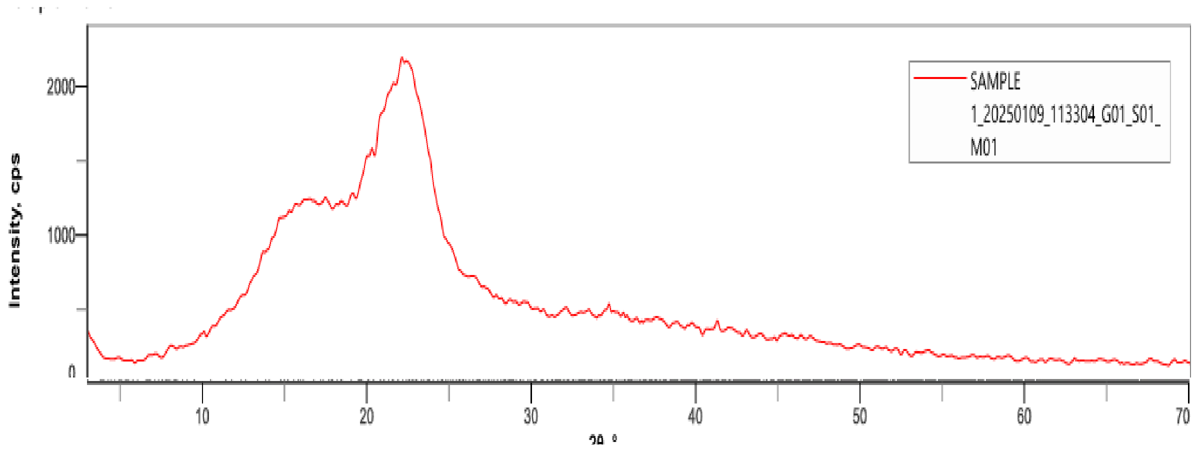

Figure 1: XRD Pattern of raw luffa sponge

The raw Banana stem XRD chart provided in Figure 2, shows the broad rise in intensity from ~10° to ~30° which suggests a predominantly amorphous structure. The sharp peak around ~24.8 ± 0.09°, likely due to carbon or silica phases, which is characteristic of carbon materials with high porosity or amorphous silica materials. The distance between adjacent crystal planes in this material was found to be 3.587 ± 0.013Å with an average crystal size of 3.13 ± 0.03 Å. Distinct crystalline peaks superimposed on the broad background indicate the presence of crystalline phases, such as flagstaffite (likely present at lower angles ~10°–20°) 43.8% [16], chaolite (contributing to peaks near ~15°–25°) 20.38% [17], aluminum phosphate hydrate (peaks at ~20°–40°) 2.61% [18], epsomite ($MgSO_4 \cdot 7H_2O$, detected in the mid-range ~30°–50°) 6.9% [19], marialite (peaks around ~30°–40°) 14.51%, and silicon oxide (likely contributing to broader features ~20° and above) 11.83%. The broad hump at ~20°–30° highlights the dominance of the amorphous phase, indicating a highly disordered structure typical of carbons or silica, while sharper peaks at specific 2θ values reveal embedded crystalline phases [20] The combination of amorphous and crystalline features indicates a material suitable adsorption of contaminants. Similar results were obtained by [21].

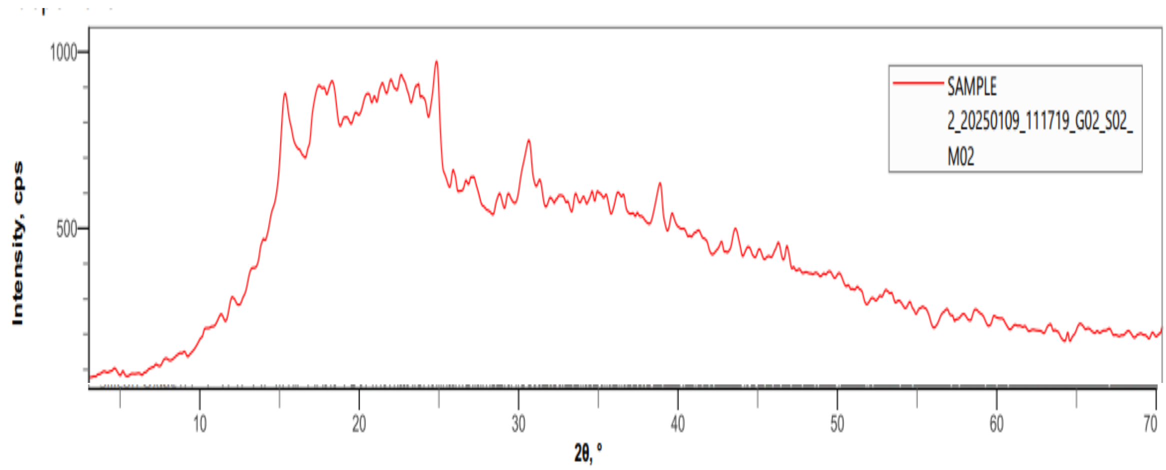

Figure 2: XRD Pattern of raw banana stem

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The XRD chart of raw *Delonix regia* seed (Figure 3) includes a strong and broad peak at approximately 20.43±0.04°, indicating the presence of amorphous material, likely carbon or silica. The distance between adjacent crystal planes in this material was found to be 4.3420±0.0009 Å with an average crystal size 9.335 ± 0.009 Å. Smaller and sharper peaks, such as those around ~10° and ~30°, suggest crystalline phases like refikite ($K_2Na_4Al_6Si_6Cl_2$...) 36.41%, chaolite 31.22%, epsomite, 4.57%, silicon oxide 13.08% and aluminium phosphate 14.70% [16]. The dominant broad peak (~20°) suggests the material is predominantly amorphous, typical of carbon or silica-based materials, while the smaller peaks highlight the presence of crystalline impurities or phases, which are secondary components. The highest intensity at ~22.43° represents the major amorphous phase, with lower-intensity peaks at higher 2θ values corresponding to the crystalline materials listed [17]. The predominance of amorphous material ensures high porosity and surface area, making the material effective in adsorption or catalysis, while crystalline impurities might add specific functionalities, such as ion exchange or catalytic activity, depending on their nature. Similar results were obtained by [22].

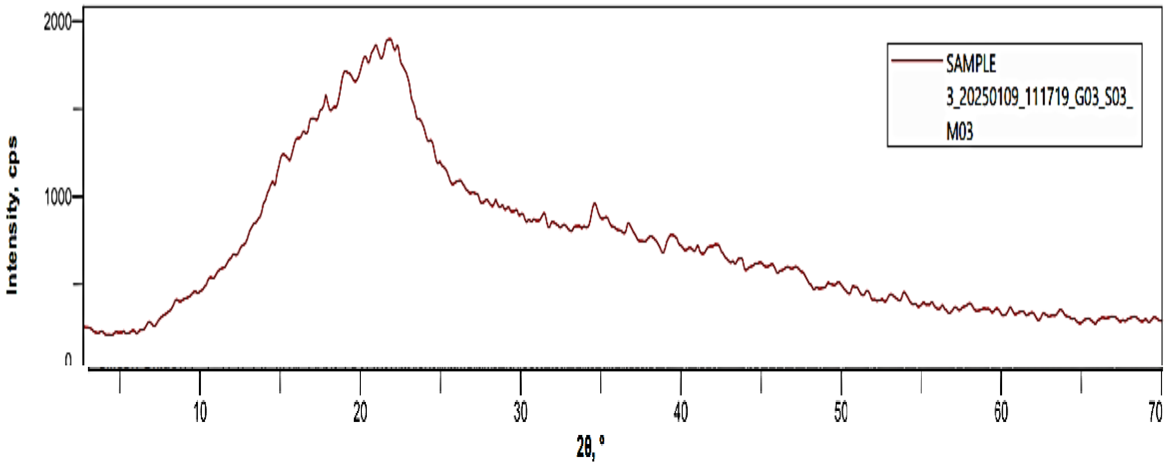

Figure 3: XRD pattern of raw *Delonix regia* seed

3.4 FTIR Profile of Precursors

The FTIR analysis of raw Luffa sponge is illustrated in Figure 4. It can be seen that from the figure that the peak 3287.5cm^{-1} could be assigned to OH^- stretching vibrations. This OH^- peak indicates the presence of water molecules in the raw luffa which shows it is not completely dehydrated. A similar result was obtained by [23]. The peak of 2922.2cm^{-1} which indicates C-H stretching of methylene and methyl groups was observed in the raw luffa sponge. The peak of 1636.3cm^{-1} can be associated with C=O and C=C stretching in the aromatic ring, a similar result was reported by [24]. The peaks of 1233.7 cm^{-1} and 1155.5cm^{-1} can be ascribed to C-O stretching and the peak of 1509.6cm^{-1}indicates N-H bending, a similar result was reported by [25].

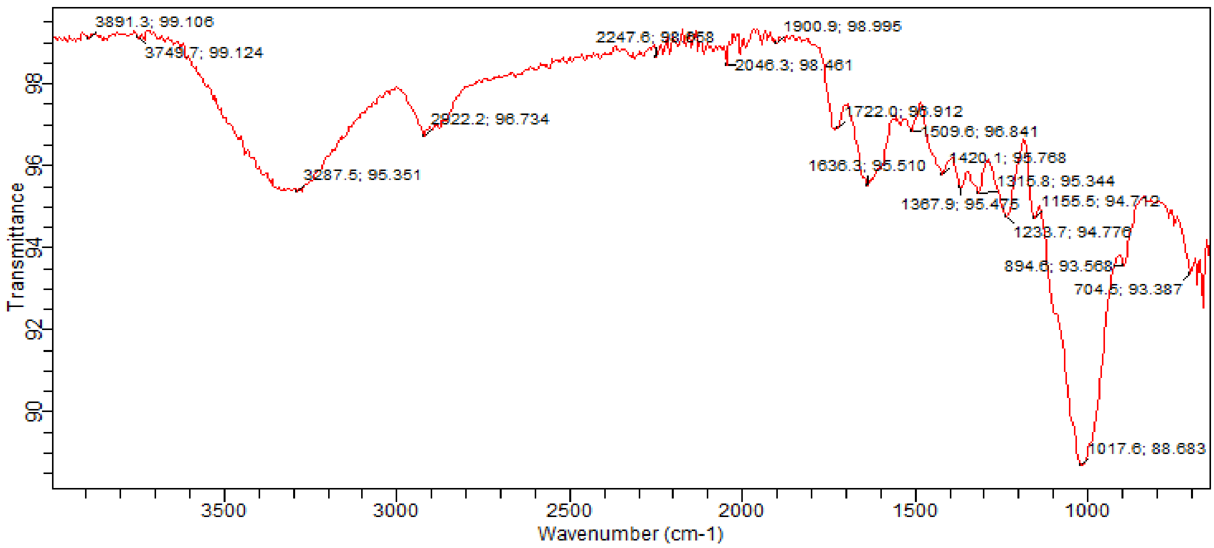

Figure 4: FTIR of luffa sponge

The FTIR of raw Banana stem is as shown in Figure 5. The peak of 3291.2cm^{-1} depicts the presence of O-H stretching of cellulose, hemicellulose, lignin and indicating the hydroscopic nature of the banana stem. Peak of

2922.2cm^{-1} indicates C-H stretching of alkyl groups, while the peak of 1606.5cm^{-1}indicates N-H bending of amines. Similar result was observed by [7, 26, 27].

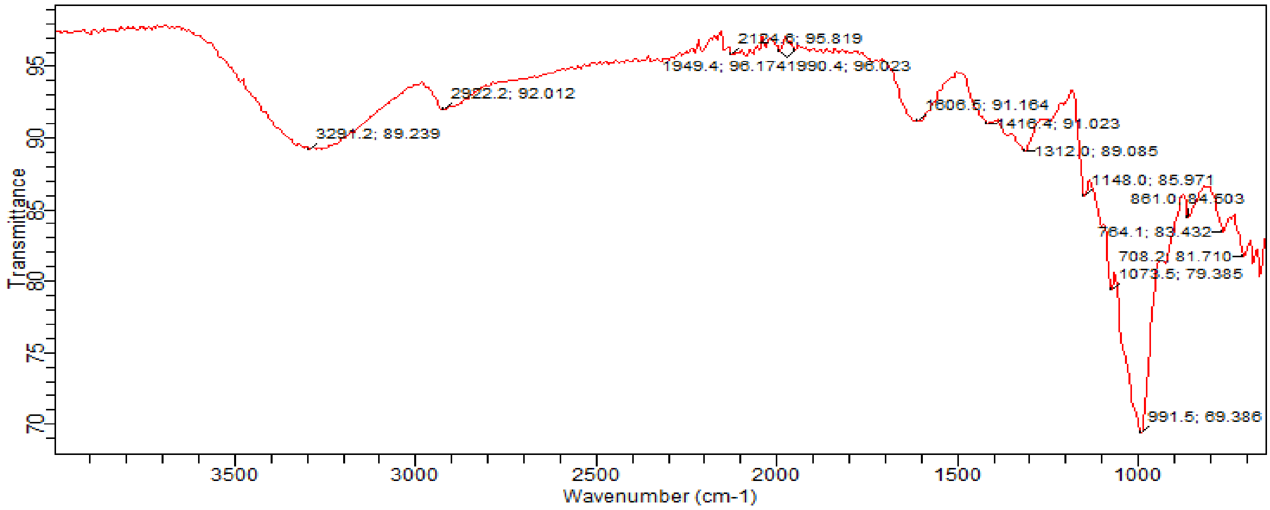

Figure 5: FTIR of banana stem

The characteristic peaks of *Delonix regia* seed FTIR from Figure 6, of 3280.1 cm^{-1} could be assigned to O-H stretching that is as a result of strong hydrogen bonding, which represents the presence of water molecules in the raw *Delonix regia* seed. Peaks 2926 cm^{-1} and 2855.1 cm^{-1} indicates C-H asymmetric stretching. peak of 1744.4 cm^{-1} indicates the presence of C=O group on the sample surface. Characteristic wavenumber peak of 1531.9 cm^{-1} indicates the presence aromatic nitro compounds, N-H bending or the presence of primary amines. Similar peaks were observed by [28].

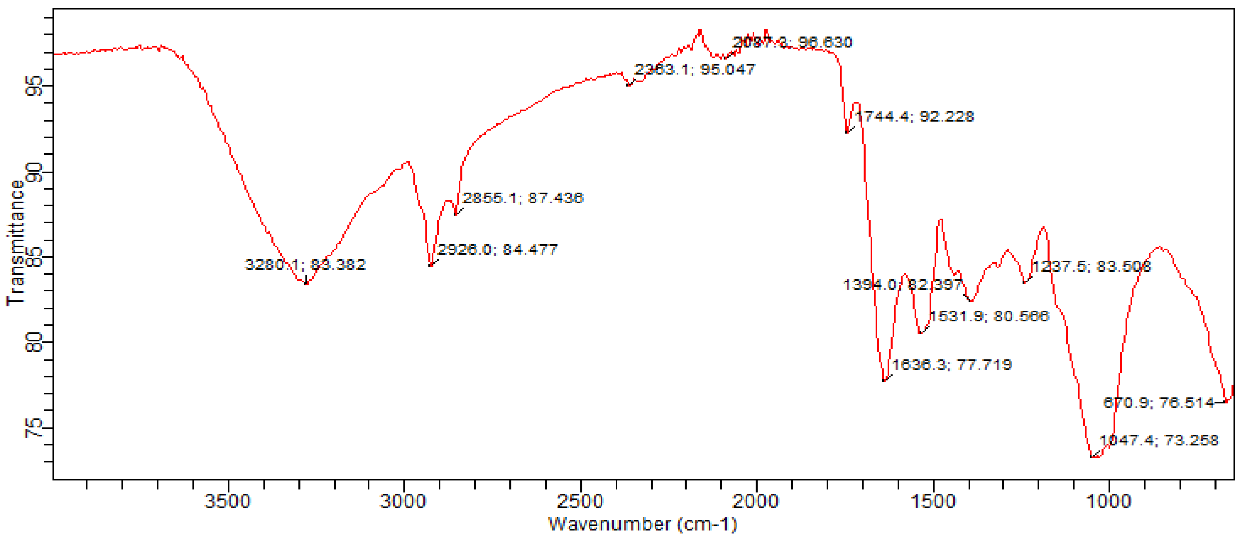

Figure 6: FTIR of *Delonix regia* seed

3.5 SEM/EDX of Precursors

The SEM micrograph of Luffa sponge, Figure 7 (a), shows a fibrous structure with tissues and pores, an indication of macro-porous nature. The finding was corroborated by [29]. Figure 7(b) shows a surface with closely pack fibers and heterogenous in nature. Similar observation was made by [21]. The *Delonix regia* seed micrograph (Figure 7 c) shows a surface aggregate that looks like aggregated circular shapes with interwoven network structure. Similar observation was made by [9].

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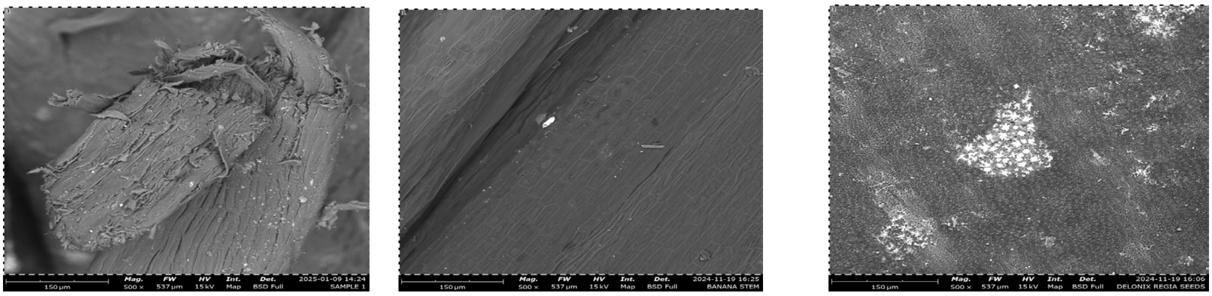

(a) (b) (c)

Figure.7 SEM micrographs (a) luffa sponge, (b) banana stem and (c) *Delonix regia* seed

EDX of Precursors (LS, BS, DRS)

The 3 major elements in LS and BS are C, N, and K while in DRS are C, N and Na. The presence of Carbon (43.08-39.79%), Nitrogen (13.13-9.72%), and Potassium (23.10-7.05%) in the 3 precursors is an indication that they will be good resource in the production activated carbon and also a biosorbent-blends. Carbon being a critical element in biomolecules, nitrogen, very important component in amines formation and potassium as a regulator of water balance, the three can synergize in their raw form as a biosorbent blend for wastewater treatment [2, 7, 10].

Table 4. EDX elemental compositions of luffa sponge, banana stem and *Delonix regia* seed

↓Elements/Material→	**Luffa Sponge** Weight %	**Banana Stem** Weight %	***Delonix regia* Seed** Weight %
Carbon, C	56.50	46.31	43.49
Nitrogen, N	21.71	20.28	19.69
Phosphorus, p	0.64	2.56	1.31
Potassium, K	3.83	11.21	9.98
Calcium, Ca	5.04	5.92	9.16
Magnesium, Mg	1.88	4.04	4.81
Chlorine, Cl	0.57	0.00	0.00
Sodium, Na	2.05	0.41	2.91
Iron, Fe	0.00	1.84	2.78
Sulfur, S	0.83	1.23	0.00
Aluminum, Al	2.75	2.40	0.70
Silicon, Si	0.00	0.43	0.00
Titanium, Ti	0.00	0.00	0.00
Bromine, Br	0.00	0.00	0.00

The EDX analysis of the samples is shown in the Table 4. For raw Luffa sponge, similar results were obtained by [24] and [30]. In the case of raw Banana stem, results obtained compared favourably with those obtained by [31]. For *Delonix regia* seeds also, similar results were obtained by [9]. The differences in some compared values may be as a result of state of maturity at the point of harvest, nature of soil the precursors were planted and processing methods.

3.6 TGA/DTA of Precursors

The TGA and DTA profiles of raw Luffa sponge, Banana stem and *Delonix regia* seed are as shown in Figure 8 – 10. The TGA curve, shows the total weight loss from the main pyrolysis of 80-94% for the 3 precursors. The weight loss up to 110^{o}C is due to lose of moisture and between 110 - 159^{o}C is due to the removal of bonded water together with other small residual molecules. From 160 - 259^{o}C and 260 - 359^{o}C may be attributed to the thermal breakdown of hemicellulose and cellulose respectively [32].

At the temperature of 330^{o}C, the mass degradations rate of LS, BS and DRS are 67.2%, 61%, and 46.5% weight respectively. As the temperature reaches 430^{o}C, devolatization of the precursors was almost complete, with only16.7%, 31.1% and 9.7% of LS, BS and DRS weights respectively is left. At 530^{o}C, the char left was 8.31%, 25.5%, and 5.2% for LS, BS and DRS respectively of their initial weights. Similar results were obtained by [19], [28] and [9] for the respective precursors.

The DTA curve shows the thermal of the 3 precursors occurs at various temperatures. At 330^{o}C, the devolatization rate were 4.62-weight loss per minute, 4.2-weight loss per minute, and 5.19-weight loss per minute for LS, BS and DRS. At 430^{o}C, the devolatization rate were 1.75-weight loss per minute, 0.87-weight loss per

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minute, and 1.74-weight loss per minute for LS, BS and DRS respectively. At 530°C, the devolatization rate were 0.38-weight loss per minute, 0.40-weight loss per minute, and 0.07-weight loss per minute for LS, BS and DRS respectively. Similar results were obtained by [30], [28], and [9] respectively for the precursors.

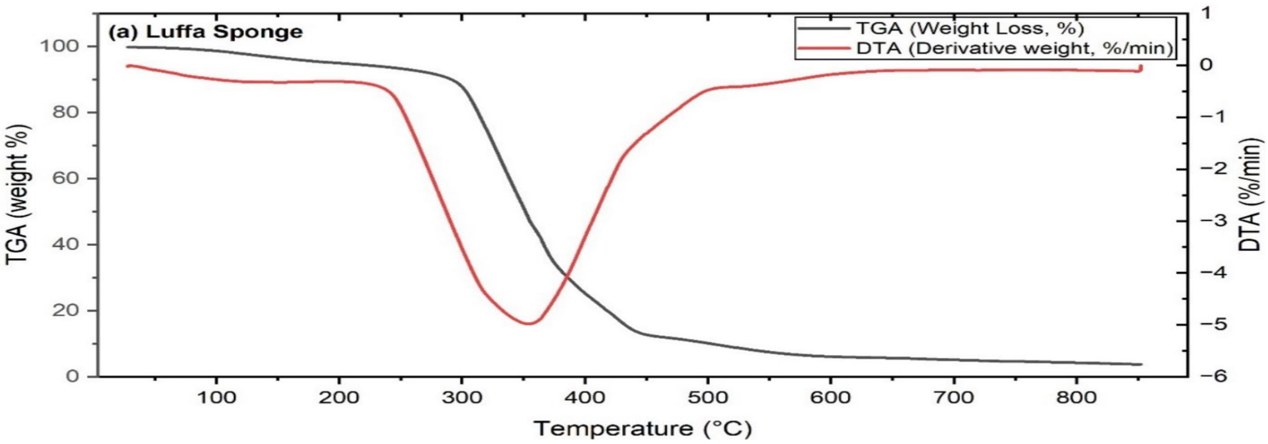

Figure 8: TGA/DTA profile of luffa sponge

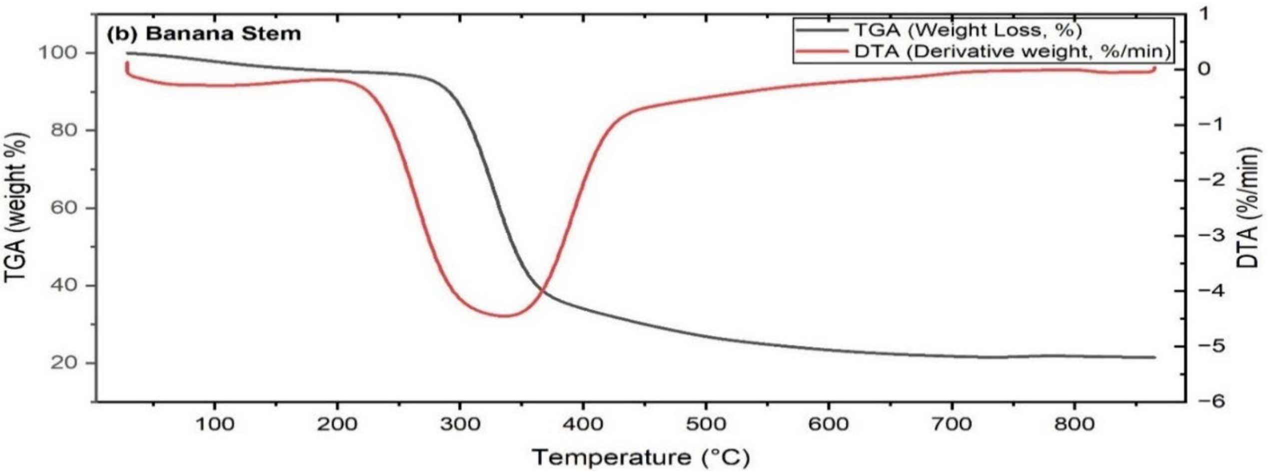

Figure 9: TGA/DTA profile of banana stem

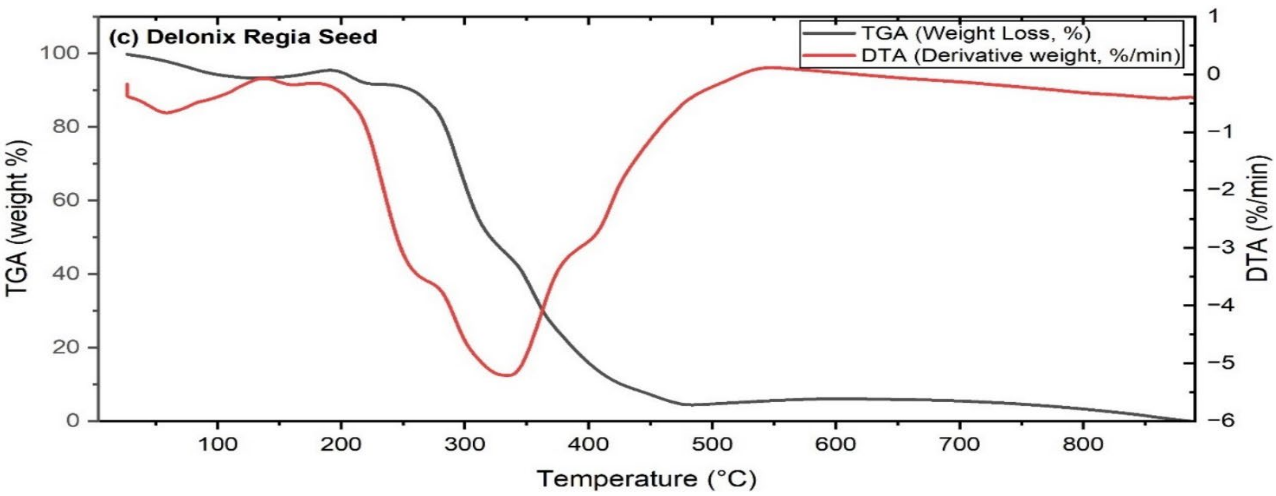

Figure 10: TGA/DTA profile of *Delonix regia* seed

4.0 Conclusion

In conclusion, industrial effluents, is one of the many sources of environmental pollutants and cause of ecological problems upon discharge to the environment. The 3 precursors, having the presence of surface functional groups, their porous nature, and high cellulose content, when blended properly, can be a veritable tool for pollutants removal, such as heavy metals adsorption, from industrial effluents. Luffa sponge is hydrophobic, oleophilic and reusable many times. Banana stem phosphorus content helps in pH stabilization(buffering) as it affects adsorption. Antimicrobial properties of *Delonix regia* seed helps in fighting bacteria and fungi, it acts as a coagulant and flocculant due to its rich content of protein. These special properties make them precursors of choice against others. Also, the precursors have the potential of further enhancement through surface treatment to improve their surface charges. Their chemical composition of silica, alumina, magnesium also will improve their strength in adsorption studies. Above all, cost of treatment will be greatly reduced by converting this waste materials hitherto, to wealth and thereby leading to a cleaner environment.

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