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Characterization of Thevetia Peruviana (Yellow Oleander) Shell Ash Powder as a Possible Filler in Polymer Composites

M.A. Usman[a], I. Momohjimoh[b*], A.S. Adeniyi[c]

[a] *Department of Chemical and Petroleum Engineering University of Lagos, Lagos, 101017, Nigeria*
[b] *Department of Mechanical Engineering Technology, University of Hafr AlBatin, Hafr AlBatin, 39524, Saudi Arabia*
[c] *Department of Mechanical Engineering, University of Saskatchewan, Saskatchewan, 22036, Canada*

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ABSTRACT

In this study, the characterization of Thevetia Peruviana shell powder and Thevetia ash powder incinerated at various temperatures (400, 500, 600, 700, 800 and 900°C) is presented. The Thevetia shells were sourced, sun dried for three days and thereafter grounded into powder. The process of making the ash involves heating the powder to the desired temperature followed by conditioning it at the same temperature for 3 hours and then cooling to a room temperature in the furnace. Elemental compositions of both Thevetia shell powder (TSP) and Thevetia ash powers (TAP) were determined using SEM-EDS analysis. The crystallinity, as well as the phases present, was evaluated with the aid of X-ray diffraction (XRD) and the results revealed that TSP is completely amorphous while TAP showed some level of crystallinity depending on the ashing temperature. Through Fourier Transform Infrared (FTIR), functional groups peculiar to TSP and TAP were elucidated which characterize both the shell powder and the ash samples. Thermal stability of the TSP and TAP was studied using differential scanning calorimetry in the temperature range (25-350°C) and the absence of volatile matters and moisture were observed in the ash samples. Scanning electron microscopy study of the samples showed that TSP image is smooth without porous structure while TAP images are fine, rough and porous, thus making the ash suitable filler materials in polymer matrix composites. Finally, Thevetia powder ashed at 600°C has proven to be the best candidate filler material in the polymer matrix due to its high silica to alumina ratio as well as its characteristic morphology.

1. Introduction

The quest for developing new materials and the improvement of the existing known materials have spurred researchers and scientists to continue to search for high performance and cost-effective materials for the benefit of mankind. Increasing demand for lightweight materials from the automobile companies for fuel efficiency has necessitated the use of fiber ash materials for reinforcing polymer matrix [1]. Lignocellulosic ash which is obtained by the incineration of lignocellulosic residues has drawn global attention in creating value-added products which would have otherwise been landfilled constituting disposal problem [2, 3].

Thevetia Peruviana (Yellow Oleander) is an ornamental shrub that is cultivated in the tropical and subtropical parts of the world. In Nigeria, Thevetia Peruviana (TP) is usually grown as ornamental plants and they are common in places like homes, schools and churches [4]. It produces flowers in small clusters usually at the tips of twigs. The flowers developed and transformed into fleshy fruits which eventually turn yellowish-brown containing two seeds [5]. TP shells are obtained after the removal of the seeds from the pods. The utilization of TP seeds for biodiesel production is well reported in the literature [6-8]. The plant is considered non-edible as accidental poisoning in human has been reported after the ingestion of the plant leaves and kernels [9]. Although natural fibers utilization as fillers in polymer composites is a subject of extensive research and a lot of developments and significant efforts have been made in this area [10-12], however to the best of the authors' knowledge, the commercial uses

* Corresponding author. Tel.: 013-7203426; Fax: 013-7247212
E-mail address: imomohjimoh@uhb.edu.sa

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Thevetia peruviana shells in both modified and unmodified forms have never been reported.

Ash is one of the most paramount characteristics of biomass which is the incombustible residue obtained after the complete combustion mainly at temperature range (500-600°C) under control laboratory or industrial conditions [13]. Thus, biomass ash refers to the solid residue that is left after complete or incomplete combustion of the organic biomass and this consists of inorganic crystalline, semi-crystalline and amorphous solid phases. Again, the ash contents of agricultural biomass depend on the part of the plant in which the ash is made. Moreover, the ash content is usually higher in vegetables and fruits than any other part of the plant [14]. Kanayo et al. [15] studied the influence of groundnut shell ash in combination with silicon carbide on the mechanical properties of Al-Mg-Si alloy. The mechanical hardness, ultimate tensile strength and the specific strength of the composites decrease with increasing contents of the groundnut shell ash, however, the percentage elongation, as well as the fracture toughness, were found to increase with the increase in the concentration of the groundnut shell ash. In another report, Mucsi et al. [16] used fly ash in combination with the waste tire as fillers in geopolymer composites. The compressive strength of the composites decreases while the flexural strength was found to improve with the addition of the fly ash. Utilization of fly ash as fillers in polymer composites [17-19] and recipe in the production of cement[20] have been studied and the authors have ascertained that fly ash is a good candidate filler material in their various applications. Atuanya et al. [21] studied the influence of bean pod ash particles on the mechanical properties of low-density recycled polyethylene composites. In their work, the bean pods were treated with 2.5% sodium hydroxide solution and thereafter packed the pods in a graphite crucible furnace and fired in an atmosphere-controlled muffle electric furnace at a temperature of 1300°C for 5 hours to obtain bean pod ash particles. The low-density recycled polyethylene and bean pod ash particles were dried, and the mixtures were compounded in a rotating twin extruder to produce bean pod ash particle low density polyethylene composites. The mechanical hardness, tensile modulus and flexural modulus of the low-density recycled polyethylene were found to improve significantly with 30wt% of bean pod ash particles. The hardness, tensile modulus and flexural modulus increase by 154%, 208% and 466% respectively with 30wt% bean pod ash powder incorporation. Besides, the tensile strength also increased by 145% on addition of 20wt% bean pod ash powder and this improvement on the mechanical properties of low-density recycled polyethylene was attributed to a fair distribution of the bean pod ash particles that restrained the chain movement of the matrix. The wear resistance and coefficient of friction of high-density polyethylene (HDPE) filled with rice husk ash and bagasse ash were studied [22] and the results confirmed that the wear resistance increased with an increase in ash content. Besides, the coefficient of friction of HDPE was found to reduce with ash incorporation. Again, the rice husk ash showed better wear resistance performance than the bagasse ash and the authors explained that the rice husk ash has high silica content relative to bagasse ash counterpart. In a related study, the addition of grounded palm oil fiber ash powder into polymer concrete has enhanced its compressive strength as the pores of the polymer concrete were reduced considerably with the incorporation of the palm oil fiber ash [23]. An extensive study on the properties of two biomass ashes (Bindlas and Silverton) was recently conducted [2]. The two ashes which were found to be highly siliceous with alumina content lower than 3% were compared to clay and the results showed that Silverton ash has higher amorphous content than the Bindlas ash while the clay is more crystalline than either of the ash. The high amorphous nature of the ashes was attributed to the presence of the unburnt carbon in the ash. Specifically speaking, ashes with high silicon content are the best candidate filler materials in the polymer matrix as silicon dissolution aid in the formation of network inorganic polymer in addition to hydration products. However, silica content alone is not sufficient to render the ash useful but the combustion temperature of the ash source which determines the ash reactivity [24]. Both particle size and crystallinity of the ash influence directly on their reactivity. Furthermore, ash with high surface area and amorphous particles is found to be most reactive although high incineration temperatures usually result in smaller particles that tend to crystallize inorganic contents of the ash and this reduces their particle reactivity [25].

Chemical analysis and characterization of ash is paramount as it serves as a tool to predict the behavior of the ash in the polymer matrix composites [26–28]. Elucidation of the functional groups available in the ash could determine the compatibility of the ash with the polymer matrix; consequently, enhance the mechanical performances of the ash-polymer composites. It is well established that the systematic identification and characterization of ash is the initial and the most vital steps for their proper utilization.

There is a huge prospect for the utilization of TP seed for biodiesel production, with a concomitant generation of TPS as waste. A suitable valorization of this potential waste should be explored. One such utilization option is its possible use as reinforcement for polymer composites. However, its suitability for this purpose must be examined via a preliminary characterization.
Despite the availability of research studies on the use of the Thevetia seed for biodiesel production, no investigation has been conducted on the application of Thevetia shell ash particles as possible filler in reinforcing polymer composites. This work, therefore, investigated for the very first time the characterization of TP powder and TP powder ash as possible filler materials in polymer composites. The TP grounded shell powder and TP ash powders were characterized using Fourier transform infrared (FTIR), Differential scanning calorimetry (DSC), X-ray diffraction (XRD) and Scanning electron microscopy (SEM).

2. Materials and Methods

2.1 Materials

The shell of TP was sourced from the University of Lagos, Nigeria staff quarters where there is a substantial number of the plant. The shells were washed and then dried in the open sun for 3 days before their preparations.

2.2 Methods

The shells of the Thevetia Peruviana (TP) were grounded into powder in a pulverized machine. Parts of the grounded powder was used for the preparation of Thevetia Peruviana ash powder (TAP). The powder was first burnt in the open air for about two hours followed by conditioning in a muffle furnace for about 3 hours as reported in the paper [15] at various temperature (400, 500, 600, 700, 800 and 900°C) to produce Thevetia Peruviana ash powder. The prepared ash powder at various temperature was designated as T400, T500, T600, T700, T800 and T900°C respectively while the powder Thevetia peruviana was not subjected to an elevated temperature treatment is designated as A.G.

2.3 Characterization of Thevetia Peruviana Fiber and Thevetia Peruviana ash powder

2.3.1 Fourier Transform Infrared (FTIR) Spectroscopy

The functional groups in the TP in both forms (as ground shell powder and ash) were qualitatively identified using the FTIR machine model 7000 FTIR Spectrophotometer. 2.5 mg of each of the sample powder was mixed with 250 mg of KBr and then compressed into pellets. The pellet was analyzed to obtain FTIR spectra and 10 scans were collected for the wave number in the range (4000 to 500 cm^{-1}).

2.3.2 Differential Scanning Colorimetry (DSC)

Thermal characterization of the TP both as ground powder and ash were studied using the DSC machine (METTLER TOLEDO) model DSC-822E. 4 mg of each of the samples were weighed and placed in aluminum crucible and covered with the lid. The sample was then transferred to the mechanical press and the pressing was done for about 2 seconds. Perforation on the cover lid was done and finally placed on the DSC machine. The range of temperature was set at 25 to 350°C at a heating rate of 0.17°C/s in an argon atmosphere.

2.3.3 X-ray Diffractometry

To study the effect of ashing on the TP fiber at various temperature (400, 500, 600, 700, 800 and 900°C), XRD analysis was done using XRD, Bruker model D8-Advance. CuKα with wavelength 1.54Å radiation was employed and the crystallinity index (CrI) was calculated based on the reflected data using the equation as reported in the paper [29],

$$CrI\ (\%) = (I_{002} - I_{am})/I_{002} \times 100 \quad (1)$$

Where I_{002} is the maximum intensity of the 002-lattice reflection formed at $2\theta_2$= 29.9, 32.3, 33.3, 28.6, 33.5 and 32.3° and I_{am} is the intensity of diffraction of the amorphous material at $2\theta_1$= 27.1, 27.2, 32.3, 32, 32.3 and 32.4° for T400, T500, T600, T700, T800 and T900 respectively.

2.3.4 Morphological Characterization

The surface morphology of Thevetia peruviana fibers both as ground powder and ash was done using a scanning electron microscope (SEM) with EDX model JSM-6460 operating at 20 KV. The sample preparations involve attachment of the powder on the studs with the aid of carbon tape. To avoid charging of the samples during SEM imaging, the samples were platinum-coated using sputter model K550.

3. Result and Discussion

3.1 Energy Dispersive Spectroscopy (EDS) Analysis

The chemical composition of most biomass ash is categories into major elements (concentration >1%), minor elements (concentration between 1-0.1%) and trace elements (concentration<0.1%). The ash-forming elements in the plant can be macronutrient (K, Ca, Mg, P, and S) while the micronutrient elements (Fe, Mn and Cl) are equally contained in the ash, although other elements such as Si, Al and Na are essential only

in some plants. The two constituents of the ash that determines their bonding strength with the polymer matrix are the silica and alumina. Ash with high silica and low alumina content is considered a suitable candidate filler material in the polymer matrix. Thus, silica to alumina ratio is usually considered in the chemical analysis of the ash. The elemental compositions of Thevetia shell powder (TSP) and Thevetia ash powder (TAP) at different temperatures after EDS analysis are shown in Table 1. Carbon and oxygen were two elements present in a large amount that was detected by the EDS. Other elements although might be present but in a minute amount that is beyond the detection limit of the instrument. The carbon composition in the TSP is 61.39 wt% while the oxygen concentration is 38.61 wt%. Thus, carbon concentration was found to decrease progressively during ashing and the emergence of other elements was acknowledged. The TAP at 400°C (T400) with silica to alumina ratio (3.5) contained other elements quantified by EDS in addition to carbon and oxygen. The carbon and oxygen concentrations of the TAP were reduced to 60.36 wt% and 29.61wt% respectively. As the ashing temperature was increased to 500°C, the carbon content reduced drastically to 35.09 wt% while the oxygen slightly increased to 32.46 wt%. The presence of other elements such as Na, Mg, Al, Si, P, S, Cl, K, Ca and Fe with varying concentration as the ashing temperature increased is greatly observed and the silica to alumina ratio increased to 3.52. Furthermore, continuous reduction in the carbon and oxygen content with increasing ashing temperature was observed and this is simply because the combustion of carbonaceous material of the Thevetia while the oxygen content reduction was because of the formation of the other elements (oxides). The concentration of Na increased from 2.07 % to 2.88% as the ashing temperature increased from 500°C to 600°C, while that of Mg equally increased from 2.62% to 3.66% as the ashing temperature is increased. The silica to alumina ratio increased substantially to 4.22 which was adjudged to be the highest among the ash investigated. The concentration of other elements was found to increase as the ashing temperature increased from 500°C to 600°C. The carbon content of T700 was about 10.88 wt% which is 20% reduction as the Thevetia ash was heated from 600°C to 700°C. Meanwhile, the oxygen concentration slightly decreased from 44.21 wt% to 43.86 wt% as the temperature of the ash increased from 600°C to 700°C. The concentration of other elements such as Na, Al, Si and K decreased while that of Mg, P, S, Cl, Ca and Fe increased as the temperature of the Thevetia ash powder was increased from 600°C to 700°C and the silica to alumina ratio of 3.58 was achieved. Continuous reduction in the carbon content of the Thevetia ash powder takes place as the ash was heated beyond 700°C although there was no significant difference in the carbon concentration between T800 and T900 samples while oxygen concentration increased from 46.39% to 48.89% as the Thevetia ash was heated from 800°C to 900°C. Again, elements such as Na, Cl, K and Ca decrease in concentration when the TAP was ashed from 800°C to 900°C. Other elements (Mg, Al, Si, P, S and Fe) were found to increase in their concentration as the ash is heated from 800°C to 900°C. The silica to alumina ratio in T800 and T900 (2.66 and 2.99 respectively) are the lowest among the ash investigated. This is in accordance with [2] who reported that high incineration temperatures would lead to small particle formation which tends to crystallize inorganic constituents. It is interesting to know that elements in order of concentration C > O > H > N > Ca > K are major elements while Si > Mg > Al > S > Fe > P > Cl > Na and in some occasion Mn and Ti are referred to as minor elements [13].This is by the trend of the result contained in the Table 1. Comparing the EDS analysis of bean pod ash particles [21] to that reported in Table 1, EDS result of the bean pod ash particles is similar to that of Thevetia ash powder particles exception of Fe, Cl, Mg and Na which are absent in the bean pod ash particles. This disparity in the qualitative value of the elements in the different ashes may be attributed to their source.

Table 1. SEM-EDS analysis of Thevetia shell powder and Thevetia ash powder

Samples	C	O	Na	Mg	Al	Si	P	S	Cl	K	Ca	Fe
A.G	61.39	38.61	-	-	-	-	-	-		-	-	
T400	60.36	29.25	0.57	0.85	0.30	1.05	1.33	-	-	2.33	3.97	-
T500	35.09	32.46	2.07	2.62	0.6	2.11	3.99	0.68	0.70	6.57	11.50	1.07
T600	13.61	44.21	2.88	3.66	0.99	4.18	5.37	0.75	0.68	9.54	12.26	1.86
T700	10.88	43.86	2.07	3.67	0.72	2.58	6.21	0.97	2.22	6.60	18.26	1.97
T800	7.10	46.39	0.94	2.96	0.83	2.21	3.77	1.31	1.52	13.30	18.00	1.04
T900	6.88	48.89	0.54	5.25	1.61	4.81	7.15	2.50	0.46	3.07	17.03	1.81

Natural biomass ash usually shows a higher concentration than the respective value for that of coal ash. It is reasonable to say that SEM-EDS determines the elemental concentrations of the ash particles at the surface although it is highly not sensitive to the morphological structure of the particle. However, SEM-EDX appears to be a good technique in estimating the concentration of main elements contained in the ash particles that are relatively affordable and faster compared to other techniques.

3.2 Differential Scanning Calorimetry (DSC)

The thermal behavior of Thevetia powder (TP) and Thevetia ash powder (TAP)was studied using differential scanning calorimetry (DSC). Fig. 1 shows the DSC curves of TP and TAP in the temperature range (25-350°C). For the TP, an endothermic peak was observed between room temperature and approximately 120°C and this is attributed to the loss of moisture and volatile organic contents. Above this temperature (120°C), exothermic reaction predominates and exothermic peak occurred between 230°C and 320°C temperature which is attributed to the decomposition of hemicellulose component[30]. Further heating beyond 320°C temperature results in simultaneous degradation of lignin and cellulose as they overlapped and this occurrence is usually in the temperature range (320°C to 400°C). It is clear from the curves in Fig. 1 that as the temperature of the ash increases, the area under the curve became smaller. This is because, most of the moisture and volatile contents of the samples have been lost and the decomposition of these volatile organic contents increases as the heating increases. Besides, T900 (Thevetia Peruviana ash at 900°C) is thermally stable as there is no observable change in the peak with temperature. This translates to the fact that at 900°C, all the moisture and organic content are lost and complete decomposition of hemicellulose, lignin and cellulose have occurred [26]. Understanding the thermal behavior of Thevetia powder and Thevetia ash powder is necessary as it aids in determining its suitable applications. Untreated Thevetia powder has large moisture contents and other impurities that will undermine its compatibility with the polymer matrix, and this hampers its bonding with the polymer matrix, consequently resulting in poor mechanical properties of the composites when used as reinforcement. Again, ashing Thevetia powder at 400°C temperature is equally not suitable as there is still appreciable organic content that may affect its bonding with the polymer matrix. Thus, ashing above 500°C temperature could produce a suitable filler material with greater bonding with the polymer matrix.

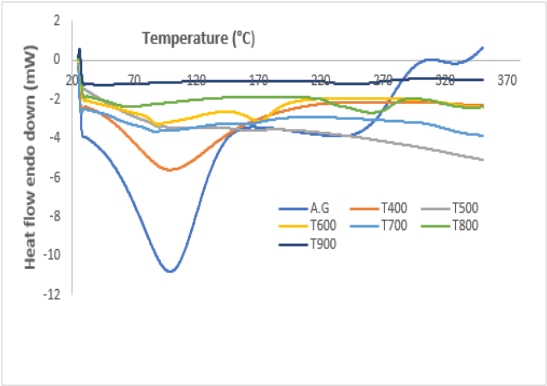

Figure 1 DSC of as-received Thevetia shell powder and Thevetia ash powders

3.3 X-Ray Diffraction

The x-ray diffraction of the TSP and TAP is shown in Fig. 2 while the XRD data is presented in Table 2. The Thevetia powder is highly amorphous as there were no observable peaks (Fig. 2) and this is ascribed to the high presence of amorphous non-cellulosic hemicellulose and lignin components. Thevetia ash powder at 400°C (T400) displayed the highest crystallinity index (45.32). The increased crystallinity could be because of the removal of amorphous components (lignin, hemicellulose), wax and other impurities caused by thermal degradation and due to the formation of inorganic salts in the ash. It is important to know that hemicellulose degradation occurred in the temperature region (230-320°C) [29, 31] while lignin degradation takes place at a temperature lower than 400°C (as reported previously in Fig. 1) and thus increase the amount of crystalline cellulose. Heating the TP above 400°C results in the decomposition of cellulose which reduced the crystallinity index as shown in sample T500 with crystallinity index (24.27) which is almost the same as T600 (crystallinity index of 24.64). The amount of these inorganic salts increased as the ashing temperature increase up to 700°C as equally revealed by SEM-EDS results (Table 1). Beyond 700°C, the evaporation of chlorides and a small amount of sulfates occurred which again reduce the crystallinity of the ash [26]. Further dissociation of sulfates and carbonates continues as the ashing temperature increased as evident in the crystallinity index presented in Table 2. For example, the crystallinity index of the T800 sample is 24.49 and this reduced to 22.60 as the ashing temperature increased to 900°C (T900). It is quite interesting to know that crystallinity has a dominant role in the overall mechanical properties of ash-polymer composites. Low crystallinity (high amorphous) ash is more reactive than the high crystalline counterparts [2].

Table 2. XRD data

Sample	FWHM1	2θ1	FWHM2	2θ2	FWHM3	2θ3	CS1	CS2	CS3	CSAVG (nm)
A.G	-	-	-	-	-	-	-	-	-	-
T400	0.1574	27.1	0.2362	29.9	-	-	54.25	36.38	-	45.32
T500	0.2362	27.2	0.4723	32.3	0.4723	33.4	36.16	18.3	18.35	24.27
T600	0.5760	32.3	0.3840	33.3	0.2362	29.8	15	22.56	36.37	24.64
T700	0.2362	32	0.3149	28.6	0.2362	33.2	36.57	26.37	36.67	33.20
T800	0.2362	32.3	0.3149	33.5	0.9446	40.2	36.59	27.53	9.36	24.49
T900	0.3542	32.4	0.3149	32.3	0.576	49.9	24.4	27.52	15.89	22.60

As the incineration temperature becomes high, the particles of the ash tend to be smaller which crystallizes the inorganic constituents consequently reducing the reactivity of the ash particles. In addition to high silica contents, other factors such as high surface area and high amorphous particles promote ash reactivity.

3.4 FTIR Results

The functional groups available in TSP and TAP are characterized by Fourier Transform Infrared (FTIR). Figure 3 shows the FTIR spectra recorded at wave number ranging from 500 to 4000cm^{-1}. The broadband stretching which occurred around 3500cm^{-1} represents OH bond [24, 30] that shows the removal of moisture in the case of TSP and Si-OH in the case of the TAP. The spectrum peak around 2919.2 cm^{-1} correspond to C-H single bond stretching [32]. The characteristic double peaks stretching at 2400 cm-1correspond to the C=O group that is attributed to the liberation of carbon dioxide (CO_2) [33, 34]. The broadband stretching between 1750 -1650 cm^{-1} which is available only in the TSP (A.G) is from the stretching of carbonyls group mainly ketones and esters. These bands predict the availability of waxes, fatty acids, fatty esters including high molecular weight aldehydes and ketones [35]. The peaks which exist between 1600-1440 cm^{-1} (1520 cm^{-1}) depict vibration of C-C and C-O stretching into the aromatic ring which is highly prominent in the ash samples [33].

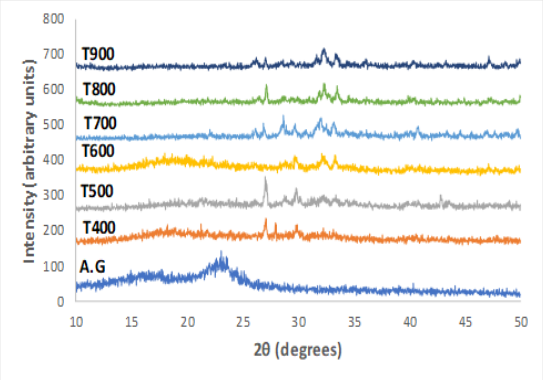

Figure 2 XRD of as-received Thevetia shell powder and Thevetia ash powders

The presence of the peak between 900 and 1100 cm^{-1} (1082 cm^{-1}) is attributed to Si-O-Al, Si group where Al, Si exists in aluminosilicate [2, 25]. It is important to know that the existence of aluminosilicate has equally been confirmed by XRD and SEM-EDS analysis. The intensity of the peaks associated with amorphous alumino-silicate vibration is proportional to the incineration temperature except for T500 which peak intensity is lower than T400.

3.5 Microstructural characterization

The morphological characterization of the selected samples is presented in Fig. 4. The scanning electron microscope image of Thevetia shell powder is shown in Fig. 4a. The image appeared to be smooth and homogenous without any porosities. Figure 4b is the SEM image of Thevetia ash powder at 500°C incineration temperature. The particles appeared finer and rough with a porous structure. However, the presence of unburnt particles of the ash is evident in the image. Figure 4c is the SEM micrograph of the TAP at 600°C incineration temperature and the particles were significantly reduced as compared to T500. Figure 4d shows the image of the TAP at 900°C incineration temperature. Rough and fine particle features of the ash were observed, and the presence of porosities was equally noticed.

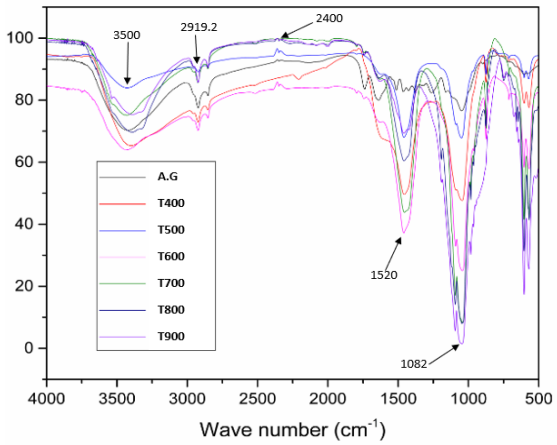

Figure 3 FTIR of thevetia shell powder and thevetia ash powder at various incineration temperatures (400, 500, 600, 700, 800 and 900°C)

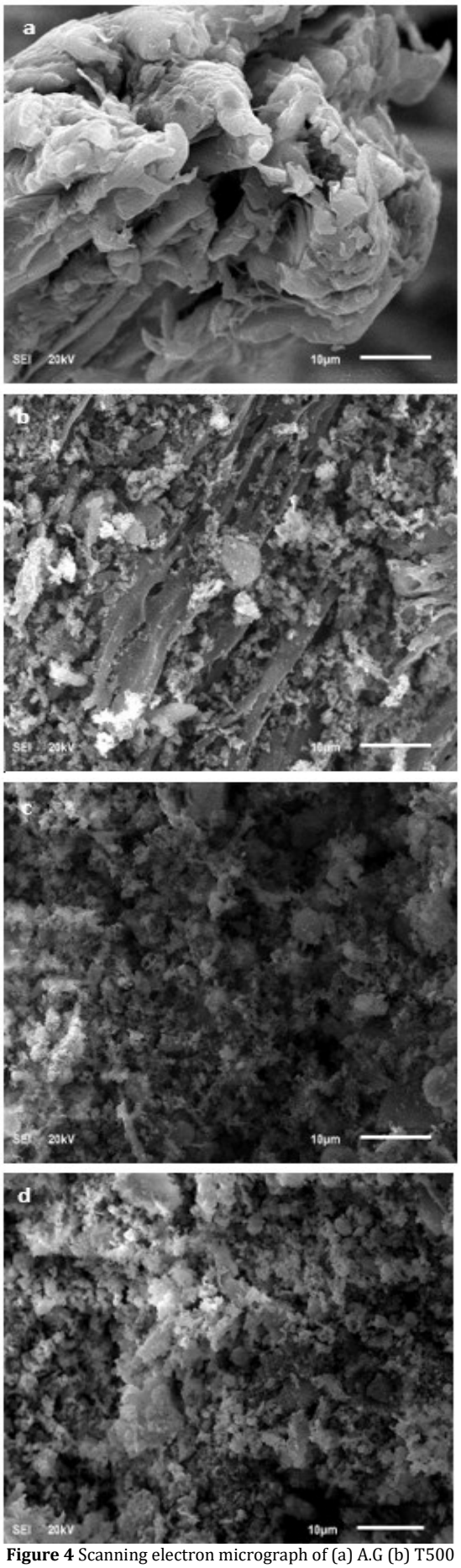

Figure 4 Scanning electron micrograph of (a) A.G (b) T500 (c) T600 (d) T900

This differs from the morphology of the bean pod ash particles which has rounded shape with a small amount of the ash particles having longitudinal in shape. Thus, a combination of surface roughness and fines particles of the TAP with the porous structure is expected to promote interfacial bonding with the polymer matrix, consequently, enhance the mechanical performances of the resulting Thevetia ash powder polymer matrix composites.

Furthermore, the investigated Thevetia ash particles could be use in the reinforcement of recycled polyethylene and polypropylene. Interesting mechanical properties and thermal stability of the TAP/recycled polyethylene composites would be expected just like bean pod ash particles have display amazing mechanical performance in the reinforcement of recycled polyethylene [21]. The future direction of this work will focus on the use of the Thevetia ash powder particles in the reinforcement of selected polymer matrix. The composites that may be produced will find applications in the production of indoor and outdoor automotive parts.

4. Conclusions

In this work, Thevetia peruviana shell and Thevetia ash powder at various incineration temperatures were studied. The elemental compositions of both TSP and TAP were determined by SEM-EDS and silica to alumina ratio for all the ash samples was equally evaluated. T600 sample displayed the highest silica to alumina ratio while T800 and T900 both have the lowest silica to alumina value. The presence of major elements (C, O, H, Ca, K) and minor elements (Si, Mg, Al, S, Fe, P, Cl and Na) were highly acknowledged. DSC characterization showed that Thevetia ash powders are thermally stable however, T400 showed the availability of volatile matters which were not incinerated hence T500 and above are highly stable with respect to A.G and T400 samples. As-received Thevetia Peruviana powder does not show any crystallinity while Thevetia ash powder displayed some level of crystallinity depending on the ashing temperature. The crystallinity of the ash was found to decrease as the temperature of the ash was raised. FTIR analysis revealed the presence of OH group in the TSP and TAP while the availability C-C aromatic stretching and Si-O-Al in the ash samples only were detected and this confirmed the availability of aluminosilicate in the Thevetia Peruviana ash powders. The morphological structure of the TSP and TAP was studied by SEM and the image of the TSP is smooth without any porous structure. However, the images of the TAP are rough, fine and porous making the ashes better candidate filler material in the polymer matrix.

Acknowledgments

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