# STRUCTURAL INVESTIGATION OF PEANUT SHELL BIO-CHAR

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## Abstract

Bio-char were prepared from peanut shell by thermal conversion of biomass. Peanut shells were dried in sun-shines to remove moisture. The dried peanut shells were ground to become powder and heated at 200 °C - 800 °C for 1 h respectively. After heating, bio-char was obtained. Structural properties of peanut bio-char were examine by X-ray diffraction (XRD). Scanning electron microscopy (SEM) was used to observe microstructure of bio-char. Functional groups in these bio-chars were investigated by Fourier transform spectroscopy (FT IR).

**Keywords** : Bio-char, XRD, SEM, FTIR

## Introduction

Bio-char is a by-product of biomass pyrolysis (residues of crops, wood trees, turfgrass, animal, manure, etc) which is undertaken to generate energy[ Lee, J.W *et al*., 2010 ]. Bio-char can be produced from almost of many types of feedstock as there are types of biomass including agricultural wastes, rice husks, bagasse, paper products…). Peanut shell is a kind of a agriculture waste and it is most available in many parts in Myanmar. It can be used as removal of pollutants from aqueous solution, for removal of heavy metal ions from aqueous medium, effect and perspectives for land reclamation, pollutants removal, carbon sequestration and soil amelioration. The pyrolysis is thermo chemical process and it converts the bio-waste into liquid, gas and solid product [Dmitri A 2011].

Biomass is conducive to environmental protection and sustainable development. Various kind of biomass has been transformed into porous carbon materials, such as corncob end straw rice husks, as well as banana leaves and stalks [Beguin, F. *et al*., 2014]. Porous activated carbon derived from peanut shells was used widely not only in the field of environmental protection as an efficient adsorbent to remove heavy metal ions and organic dyestuff in waste water but also in power sources such as lithium-/sodium- ion, batteries, and super-capacitor. [Georgin, J. *et al*., 2016]. Peanut shell is having different chemical composition, material morphologies, surface functionalities, carbon properties, which attracted great attention to utilise it as the precursor to produce the activated carbon [Hassan, A F. *et al*., 2014].

The activated carbon extracted from peanut shell can be utilised for the fabrication of electrode for energy storage devices like super capacitors and batteries [He, T. *et al*., 2015]. Biomass material not only contains abundant carbon, existing as cellulose, lignin and hemicelluloses, but also usually exhibits a unique hierarchical porous structure. Moreover, rational utilization of biomass is conducive to environmental protection and sustainable development. Therefore, the utilization of biomass to produce hierarchical porous carbon materials has become more and more attractive, especially for energy storage [Jiang Q. ed al 2016]. Until now, various kinds of biomass have been transformed into porous carbon materials, such as corncob and straw, rice husks, as well as batata leaves and stalks [Wer, X. *et al*., 2017].

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Peanut shell is having different chemical composition, material morphologies, surface functionalities, carbon properties, which attracted great attention to utilise it as the precursor to produce the activated carbon.

Chemically modified adsorbents have been prepared by treating raw peanut shells with three different chemical methods. Scanning electron microscope (SEM), Fourier transform in fared spectroscopy (FI TR), X-ray diffractometer (XRD) have been used to characterize these adsorbents.

## Experimental Procedure

Peanut shells were collected from Ayeyarwady Division. The collected biomaterial was extensively washed with tap water to remove soil and dust. Washing process was repeated. They were dried in sunshine for 48 hours. The dried shells were cut into small pieces and heated in the muffle furnace. The peanut shells are annealed at (200 °C – 800 °C) for 1 hour respectively. Finally, the peanut shell bio-char were obtained. The block diagram of sample preparation of peanut- shell bio-char was shown in Fig 1.The prepared peanut-shell bio-char were characterized by using an X-ray Diffractometer (RIGAKA-RINT 2000). Each chars were grained for powder diffraction using Cu$k_\alpha$ radiation (40 kV,40 mA) from $10^o$ to $70^o$ (2 θ) with 0.1 strength size and 2 sec measurement interval. The surface morphology studies of bio-char were performed using Scanning Electron Microscopy (SEM). Fourier Transform Inferred Spectroscopy (FTIR) was examined in atmosphere using (Model- JEOL-6000). Absorbance spectrum (800-4000 $cm^{-1}$) was collected for each sample.

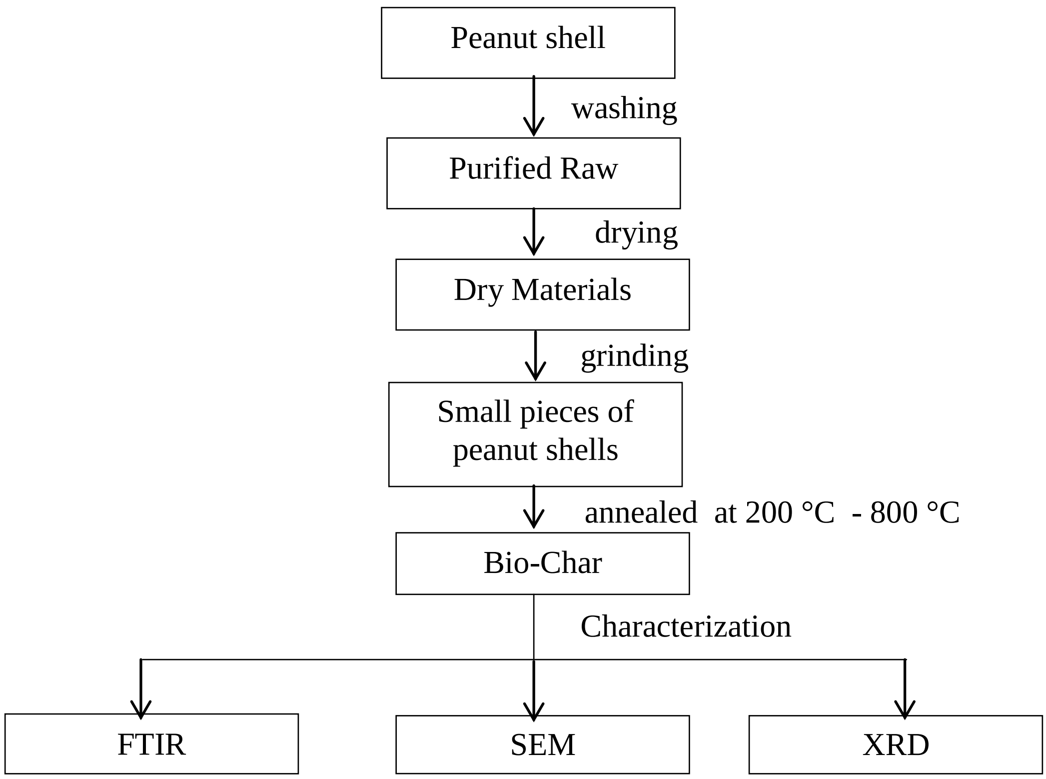


**Figure 1** Flow Chart of Characterization of bio-char material

## Results and Discussion

### FTIR Analysis of Peanut shell Bio-char

FTIR spectroscopy was applied to measure the chemical properties and absorption of energy from the range of 800 $cm^{-1}$- 4000 $cm^{-1}$ by studied samples. Spectral registration was examined with use of solid-state samples which is made of a complex organic material. The FTIR analysis demonstrated the functional groups presented on peanut shell bio-char. From the Fig. 2(a-d ), an annealing temperature from 200 ºC to 500 ºC , the range at 3500-3200 $cm^{-1}$ was shown O-H stretch and H bonded bond in alcohol, phenons functional group. And also stretch bands between 1534-1586 $cm^{-1}$ were found in N-O asymmetric stretch nitro compound functional group and the peak at 1157 – 1200 $cm^{1}$ formed to be C_O stretch alcohols, carboxylic acid, esters and ethers group. From the figure 2(e-g) the peak at 2260-2100 $cm^{-1}$ is associated to C≡C stretch alkynes functional group. The functional groups of the peanut shell samples at 200 ºC to 500 ºC have found to be O-H stretch, N-O asymmetric stretch and C-O stretch alcohols, carboxylic acid, esters and ethers group . At 600 ºC to 800 ºC C≡C stretching vibration was occurred.

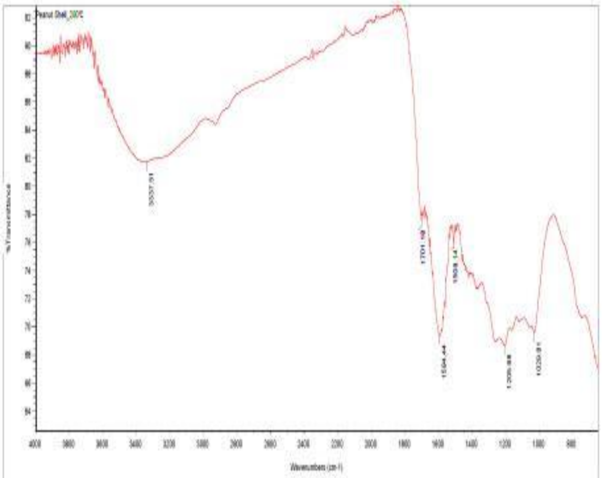

**Figure 2(a)** FT IR spectra of peanut shell bio-char at 200 ºC

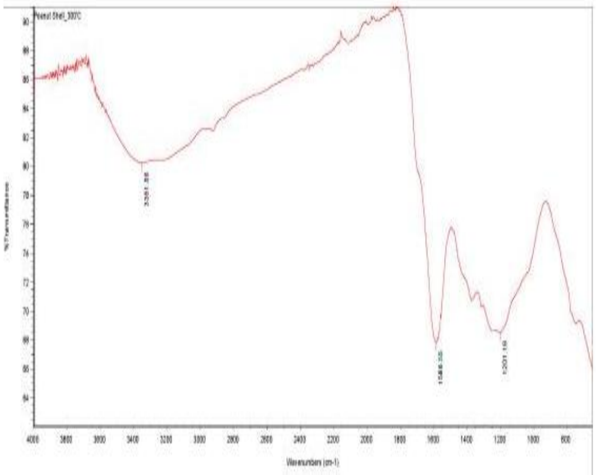

**Figure 2(b)** FTIR spectra of peanut shell bio-char at 300 ºC

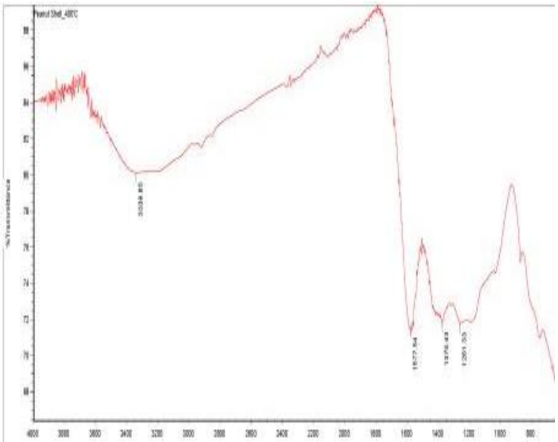

**Figure 2(c)** FTIR spectra of peanut shell bio-char at 400 ºC

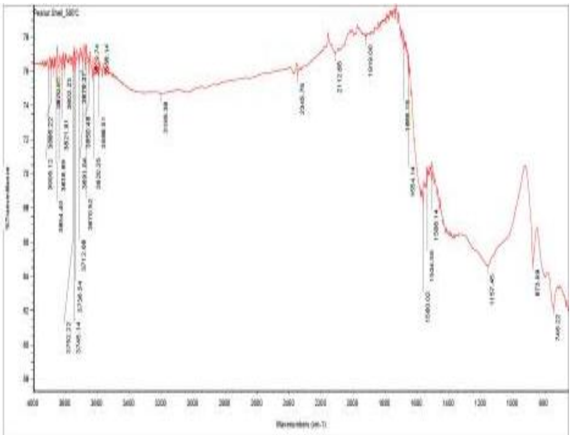

**Figure 2(d)** FTIR spectra of peanut shell bio-char at 500 ºC

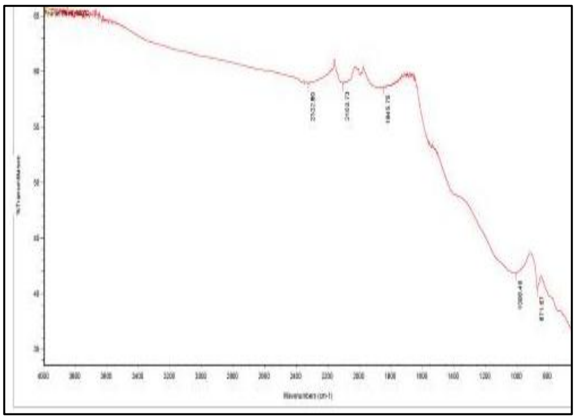

**Figure 2(e)** FTIR spectra of peanut shell bio-char at 600 ºC

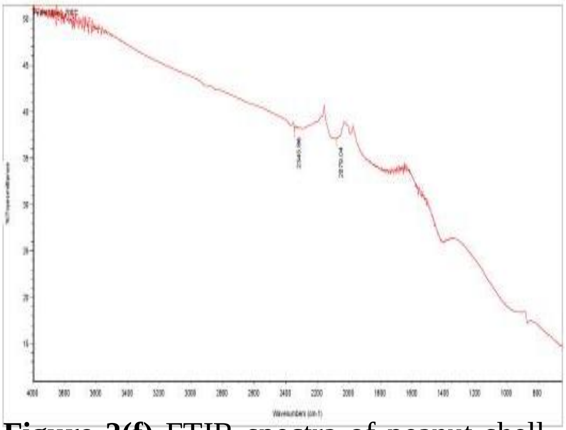

**Figure 2(f)** FTIR spectra of peanut shell bio-char at 700 ºC

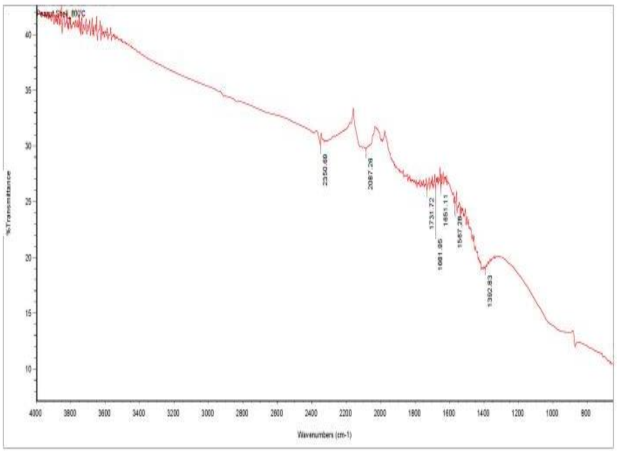

**Figure 2(g)** FTIR spectra of peanut shell bio-char at 800 ºC

**SEM Analysis**

Scanning electron micrographs for external morphology of peanut shell bio-char at temperatures 200 ºC to 800 ºC for 1 hour were shown in Fig. 4(a-b), the porous nature was found that the peanut shell bio-char had porous nature with micro-porous structure. From SEM images, it was found that the surface morphology and nature of pores size changes with different temperatures. From Figure 3(a – e) the pore size becomes smaller and smaller with increasing temperatures between 200 ºC and 600 ºC. At higher temperatures, 700 ºC and 800 ºC the pore sizes were very small and irregular in size. In 800 ºC, the crushed pieces of the peanut shell biochar became smaller due to the heat treatment and formed flakes layers. All figures exhibited the smooth in morphology, grain size and pores qualities of all samples were fabricated by pyrolysis method.

**Table Average pore diameter of peanut shell biochar with different temperatures from SEM image**

| Sr | Temperature (ºC) | Time ( h) | average pore diameter ( µm) |
|---|---|---|---|
| 1. | 200 | 1 | 8.39 |
| 2. | 300 | 1 | 6.22 |
| 3. | 400 | 1 | 5.80 |
| 4. | 500 | 1 | 5.18 |
| 5. | 600 | 1 | 3.40 |
| 6. | 700 | 1 | 1.91 |
| 7. | 800 | 1 | 1.72 |

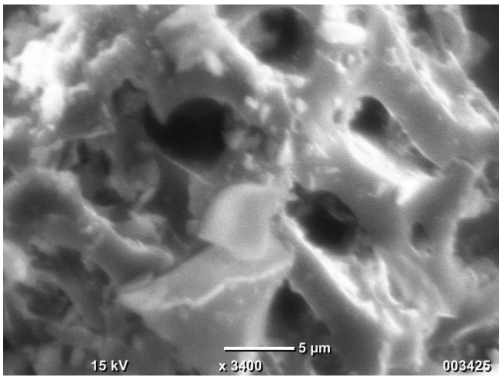


**Figure 3(a)** SEM image of Peanut Shell bio-char at 200 ºC

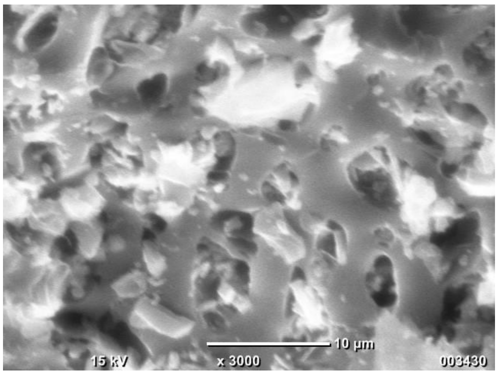


**Figure 3(b)** SEM image of Peanut Shell bio-char at 300 ºC

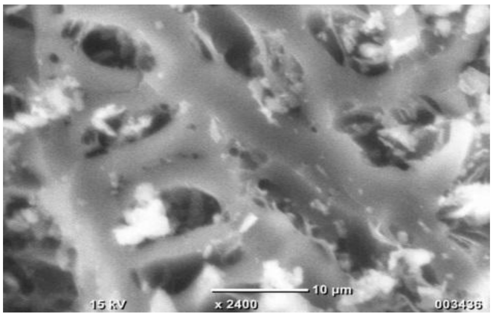


**Figure 3(c)** SEM image of Peanut Shell bio-char at 400 ºC

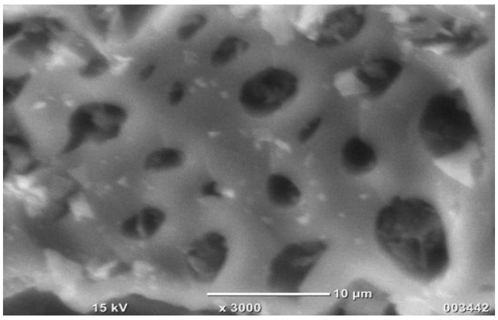


**Figure 3(d)** SEM image of Peanut Shell bio-char at 500 ºC

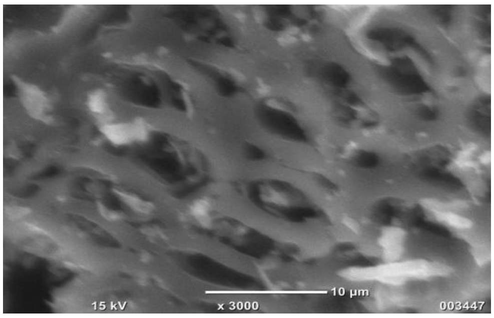


**Figure 3(e)** SEM image of Peanut Shell bio-char at 600 ºC

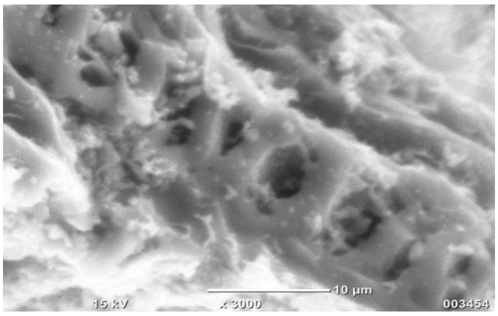


**Figure 3(f)** SEM image of Peanut Shell bio-char at 700 ºC

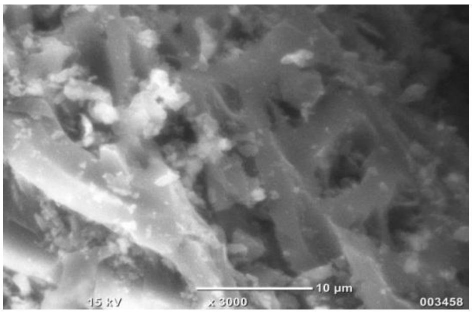


**Figure 3(g)** SEM image of Peanut Shell bio-char at 800 ºC

## XRD Analysis

The peanut shell bio-char and were analyzed by XRD technique. The XRD spectra of peanut shell bio-char at 200 ºC to 800 ºC for 1 h were shown in Fig. 4 (a-g). According to XRD analysis, five diffracted peaks were observed. They were not perfectly identified. It could be said that peanut shell bio-char was amorphous material with little crystalline. It was found that five diffracted peaks were formed and they were matched with the peaks of Carbon, Graphite and diamond peaks.

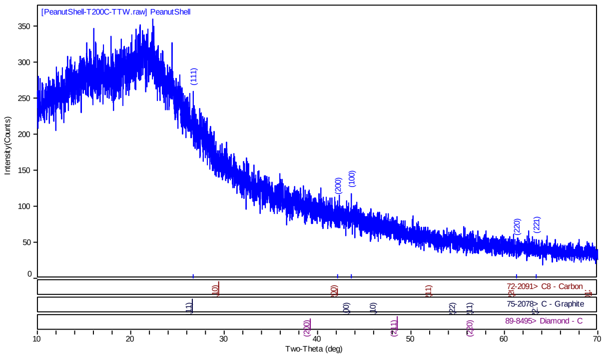


**Figure 4(a)** The XRD pattern of peanut shell bio-char at 200 ºC for 1 hr

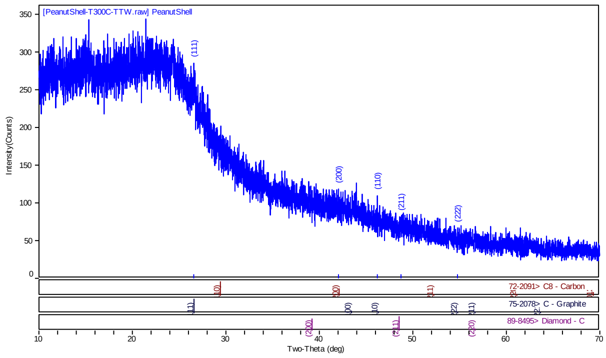


**Figure 4(b)** The XRD pattern of peanut shell bio-char at 300 ºC for 1 hr

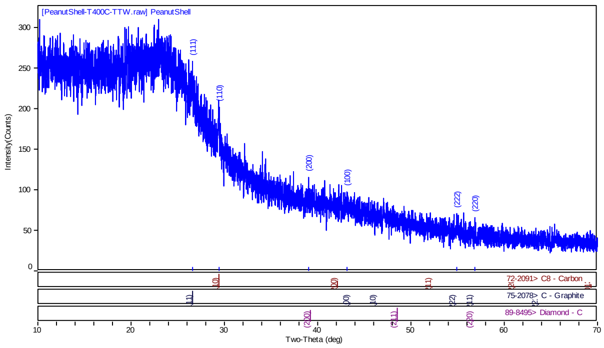


**Figure 4(c)** The XRD pattern of peanut shell bio-char at 400 ºC for 1 hr

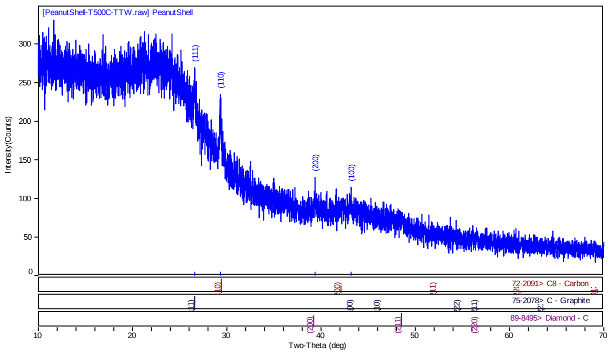


**Figure 4(d)**The XRD pattern of peanut shell bio-char at 500 ºC for 1 hr

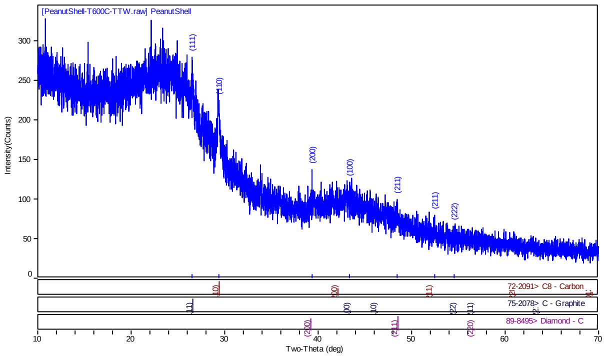

**Figure 4(e)** The XRD pattern of peanut shell bio-char at 600 ºC for 1 hr

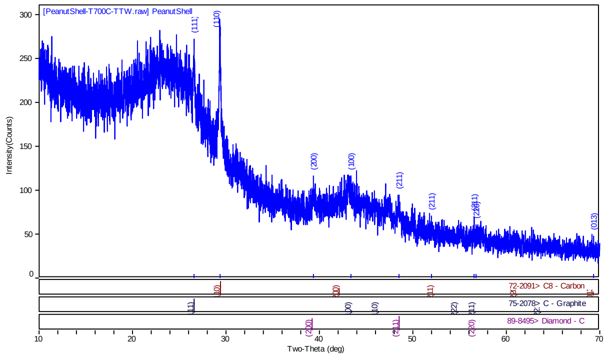

**Figure 4(f)** The XRD pattern of peanut shell bio-char at 700 ºC for 1 hr

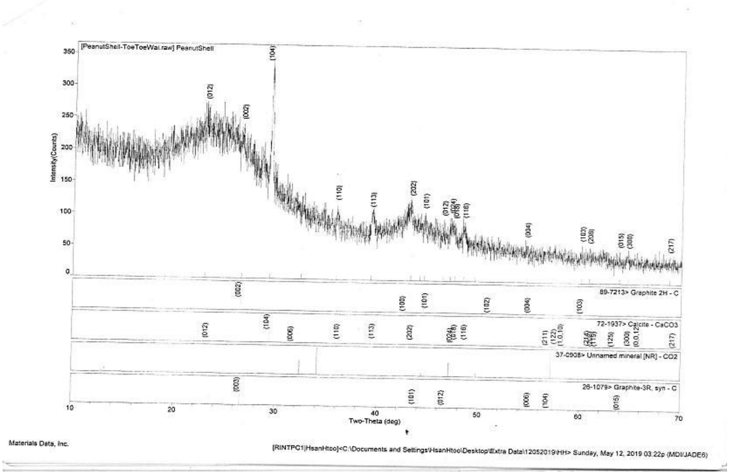

**Figure 4(g)** The XRD pattern of peanut shell bio-char at 800 ºC for 1 hr

## Conclusion

Bio-char are produced in a muffle furnace from the peanut shell of bio-mass. The .XRD spectra, SEM images and FTIR spectra of peanut shell bio-char were studied. As a result of XRD, the peanut shell bio-char at different temperatures (200 °C – 800 °C) were matched with carbon. From SEM image peanut shell bio-char could be said that it has porous nature. The Bio-char undertake a number of significant changes in chemical composition. These changes can easily be examined by FT IR analysis. The results suggested that the peanut shell bio-char can be used as an efficient quality for production of renewable sources based on activated carbon.

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