STUDY ON DIFFERENT PYROLYSIS TEMPERATURES OF DRACONTOMELON DAO (PACIFIC WALNUT) BIOCHAR

Nway Han Myat Thin[1], Toe Toe Wai[2], Shwe Sin Aung[3], Zin Min Myat[4]

Abstract

Biochar derived from biomass waste is accepted as multifunctional material for various applications according to its specific characteristics. It is therefore popular to investigate biochar properties under the improvement of research application. In this study, biochar derived from Dracontomelondao fruit shell (DD nut) (English: Pacific Walnut) from Moe Nyin Township, Kachin State was prepared by different pyrolysis temperatures (400, 500 and 600ºC) at one hour each. Structural properties of the resulted biochar were characterized by X-ray Diffraction (XRD) technique, infrared spectroscopy (FTIR), and Scanning Electron Microscopy (SEM) technique. Changes in properties of Dracontomelondao biochar with different temperatures were investigated.

Keywords*:* Dracontomelondao, biochar, pyrolysis temperature

Introduction

Dracontomelon-dao (Myanmar: ngapauk thee; Indonesian: dahu; Malay: sengkuang; Thai: ka-kho) also known as New Guinea walnut, Pacific walnut or Paldao, is a tropical canopy tree distinguished mostly by its height (reaching up to about 148 feet) for its grayish-brown trunk which is branchless up to about (66 ft) and for its narrow buttresses which can reach up its trunk up to (20ft) high. [Prasad.K *et al* 1993].Its lobes are divided into five lobes. In Myanmar, it is called ngapauk thee due to the fruit is divided into five lobes. Under the methodology, biochar may be produced from any biomass residues from forestry and agriculture, municipal solid waste and other biomass-based materials. In the present work, the DD nut fruit biochar is produced from sustainably managed forests from Moe Nyin Township, Kachin State (generally it is found abundantly in the Upper Myanmar). Biochar refers to the C-rich residues of incomplete combustion of biomass under oxygen limited conditions and at relatively low temperatures [Mosa*et.A.A et al* 2017]. Biochar is more benefit to attention as a functional material in environmental and agricultural application. It has been concerned with multiple benefits with the ability to improve soil fertility, generate carbon neutral energy and increase agricultural output [Harish.K.N *et al* 2013].

Experimental Procedure

The raw materials biomass collected from Moe Nyin Township, Kachin State, were shown in figure (1).The DD nut fruit shells were washed with fresh water to remove soil, dust and other impurities. After washing many times, these shells were dried under sunlight to remove the moisture content. To dry completely, these shells were taken under sunlight about one week. Then the dried and cleaned biomass was heated at 400ºC, 500ºC, 600ºC for one hour each in a muffle furnace. Finally the resulted solid biochar were obtained in figure (2). These biochars were grounded with the aid of agate motor for two hours each to obtain the fined powder biochar. The block diagram was shown in figure (4). These biochars were characterized by XRD, SEM and FTIR spectroscopy.

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Figure 1 Photographs of Dracontomelon dao plant and fruit shell

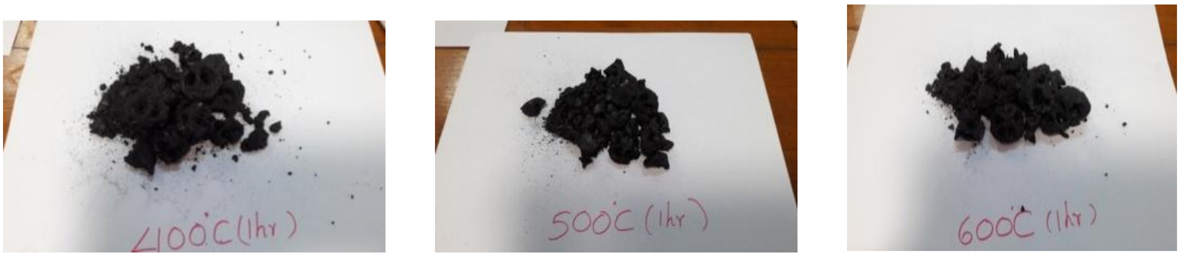

Figure 2 The photograph of solid Dracontomelon dao shell biochar after heating

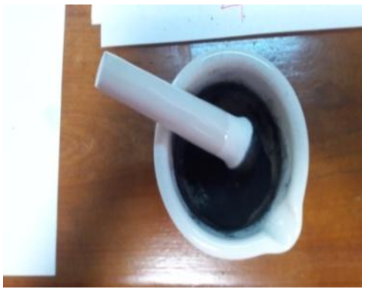

Figure 3 The photograph of powder Dracontomelondao shell biochar

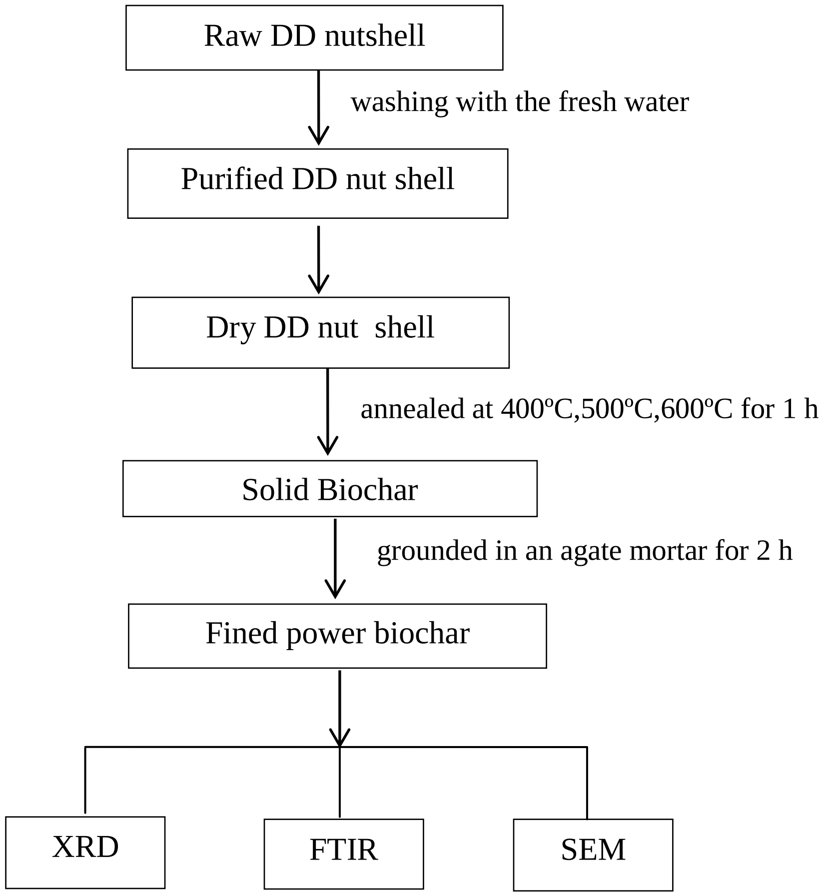

Figure 4 Block diagram for preparation of Dracontomelon dao shell biocher

Results and Discussion

The experimental results and discussion from XRD, SEM and FTIR measurement of Dracontomelon dao shell powders prepared at different temperatures 400ºC, 500ºC, and 600ºC for 1*h* each**.**

XRD Analysis of Dracontomelon Dao Shell Biochar

X-ray diffraction technique (XRD) is a powder technique for dimension of crystal structure, interplanar spacing by using X-ray beam. XRD was used to detect crystalline phase and amorphous structure and any compound were included in this biochars. The XRD spectra on different pyrolysis temperatures (400˚C, 500˚C and 600˚C for 1*h)*were shown in figure 5(a-c). According to XRD result, there are some dominant peaks were observed and other were not perfectly identified. It count be said that the biochar of three different temperatures were found to be amorphous structure with little crystalline peaks. All of the results were found the same metals in the spectra as graphite, carbon, diamond and chaoite.

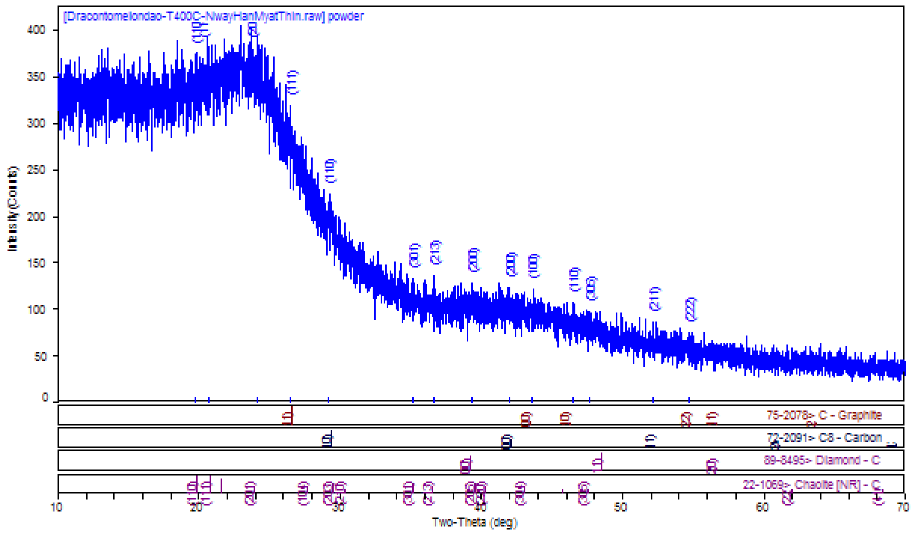

Figure 5 (a) XRD Pattern of Dracontomelon dao shell biocher prepared at 400℃

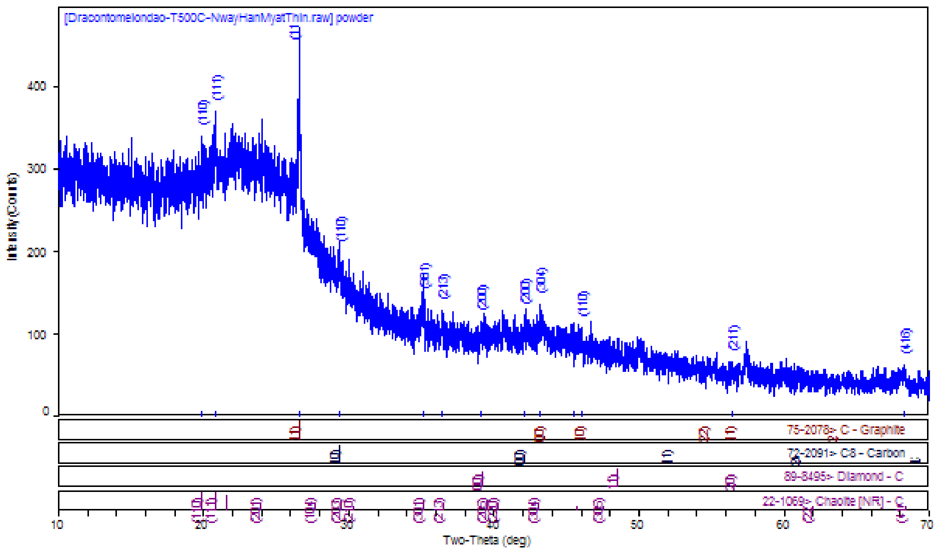

Figure 5 (b) XRD Pattern of Dracontomelon dao shell biocher prepared at 500℃

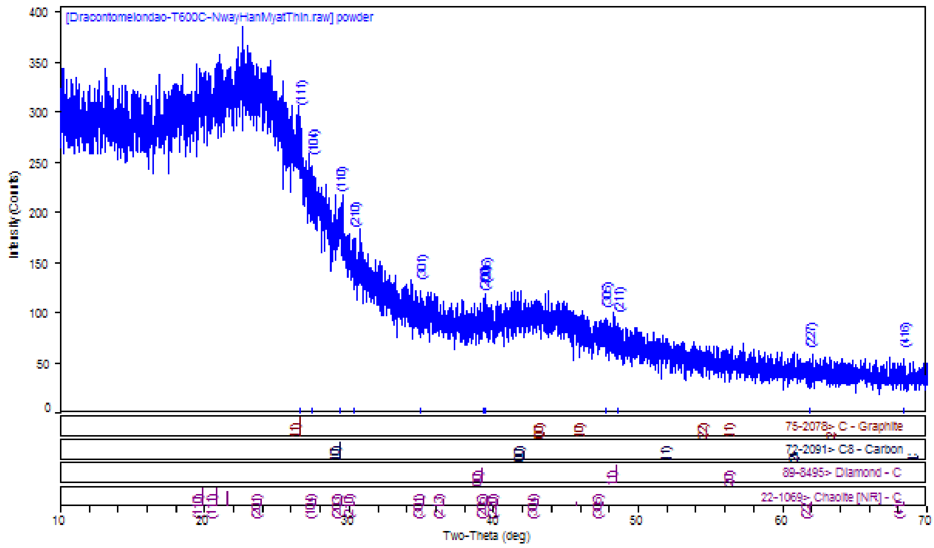

Figure 5 (c) XRD Pattern of Dracontomelon dao shell biocher prepared at 600℃

SEM Morphology of Dracontomelon Dao Fruit Shell Biochar

SEM micrographs for surface morphology of DD nut shell biochar at 400˚C, 500˚C,600˚C for 1h were shown in figure 6(a-c).It can be concluded that the microstructures of DD nut shell biochar were varying the pore sizes with different temperatures. The average pore sizes of the samples were found to be about 9.5µm in 400˚C, 7.9µm in 500˚C, 5.4µm in 600˚C respectively. All the samples presented well-defined pores structure and contained mesopore, micropore and macropore structures.

Table 2 Average Pore Diameter of Dracontomelon Dao Shell Biochar with Different Temperatures from SEM Image

Sr	Temperature (°C)	Time (*h*)	Average pore diameter (µm)
1	400	1	9.5
2	500	1	7.9
3	600	1	5.4

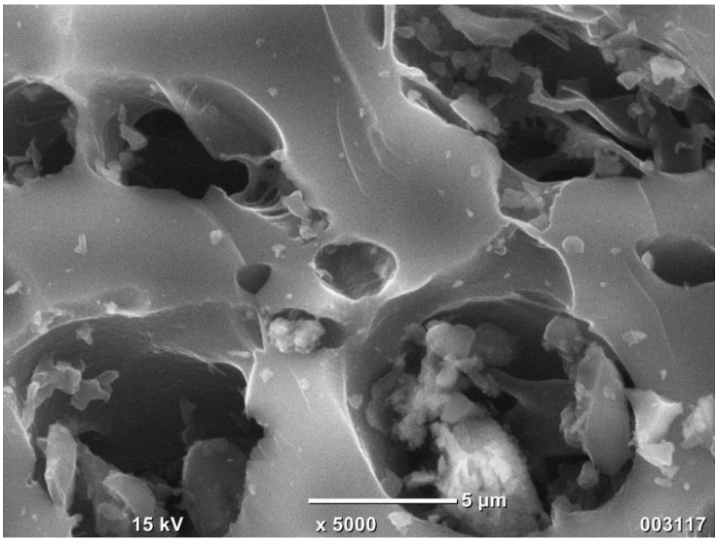

Figure 6(a) SEM photograph of Dracontomelon dao shell biocher prepared at 400℃

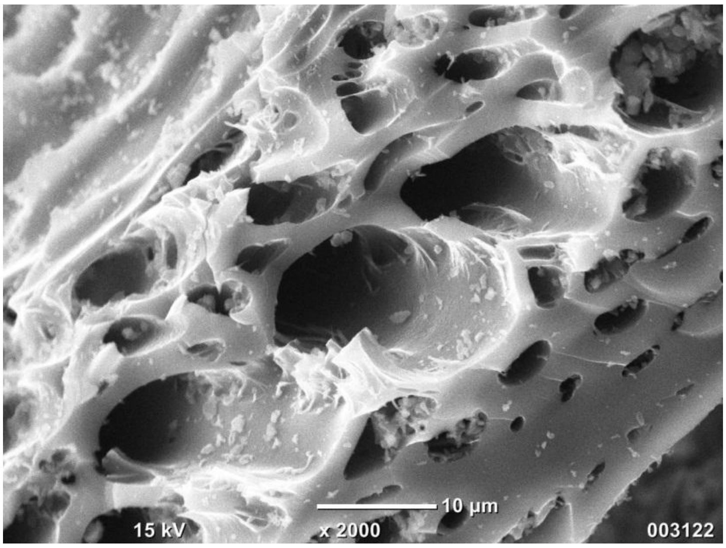

Figure 6 (b) SEM photograph of Dracontomelon dao shell biocher prepared at 500℃

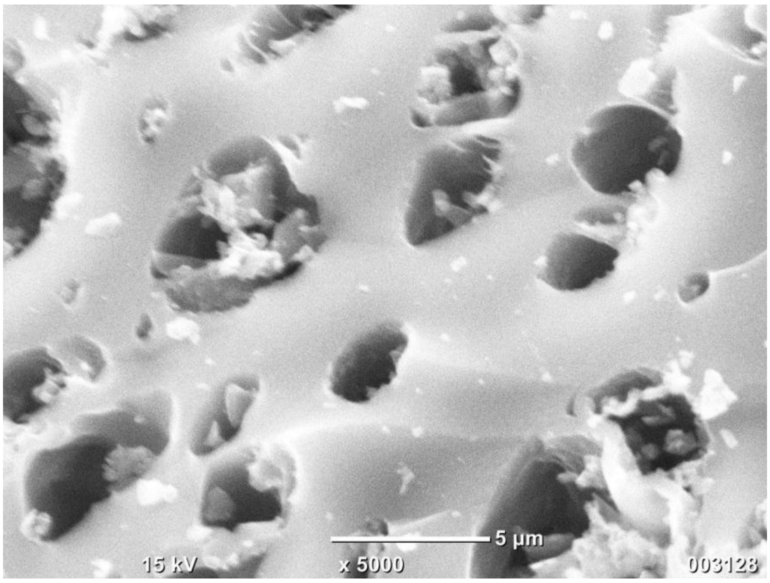

Figure 6 (c) SEM photograph of Dracontomelon dao shell biocher prepared at 600℃

FTIR spectrum Study of Dracontomelon Dao Shell Biocher

The surfaces chemistry of the sample was analyzed by identifying the surface functional groups the samples using Fourier transform infrared spectroscope. The spectra were recorded from 4000 to 400 cm^{-1} resolution in the mid-infrared region. The FTIR analysis demonstrated on different pyrolysis temperatures (400˚C, 500˚C,600˚C) of DD shell were shown in figure 7(a-c). For 400˚C, the first peak at 3179.57 cm-^{1} indicates O-H stretch bond carboxylic acids vibration. The two peaks that are located at (2346.09 cm^{-1}and 2112.57 cm^{-1} for 400˚C) and (2113.72 cm^{-1} and 1919.76 cm^{-1} for 500˚C) observed -C (triple bond) C-stretch alkynes vibrations. The peaks observed at 1577.67 cm^{-} ^{1}for 400˚C and 1573 cm^{-1} for 500˚C were indicated C-C stretch in ring aromatic vibrations. Also the peaks (1162.32 cm-^{1} for 400˚C and 1159.04 cm^{-1} for 500˚C) were found C-O stretch alcohols, carboxylic acid, esters, ether vibrations. The last peaks that are located at 748.15 cm^{-1} in 400˚C and 746.33 cm^{-1} in 500˚C showed the presence of C-H 'oop' bond with aromatics functional groups. FTIR results for 600˚C were shown in figure 7(c). The first two peaks at 2323.22cm^{-1} and 2083.83 cm^{-1} indicated the -C (triple bond) C-stretch alkynes vibrations. Out of these, the peak at 1000.42 cm^{-1} showed C-N stretch modes of aliphatic amines compound. According to FTIR analysis, -C triple bond C-stretching vibrations of alkynes group are consistent with all the samples. The polar group (-OH and CO) significantly decreased when heated to 600˚C. In fact, the functional groups observed on the biochers included, CH, OH, C≡C and C-O, were observed to biocher activities.

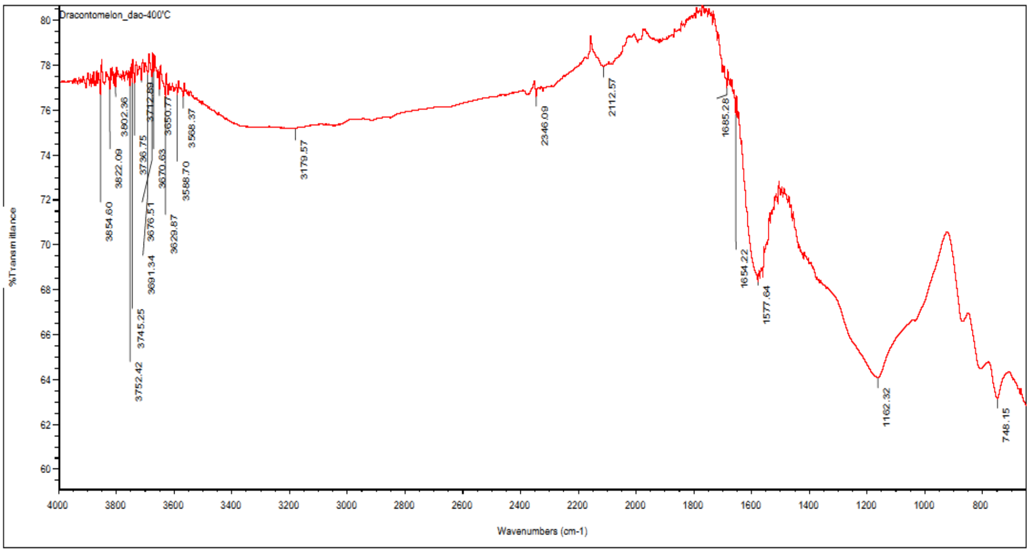

Figure 7 (a) FTIR analysis of Dracontomelon dao shell biocher at 400°C

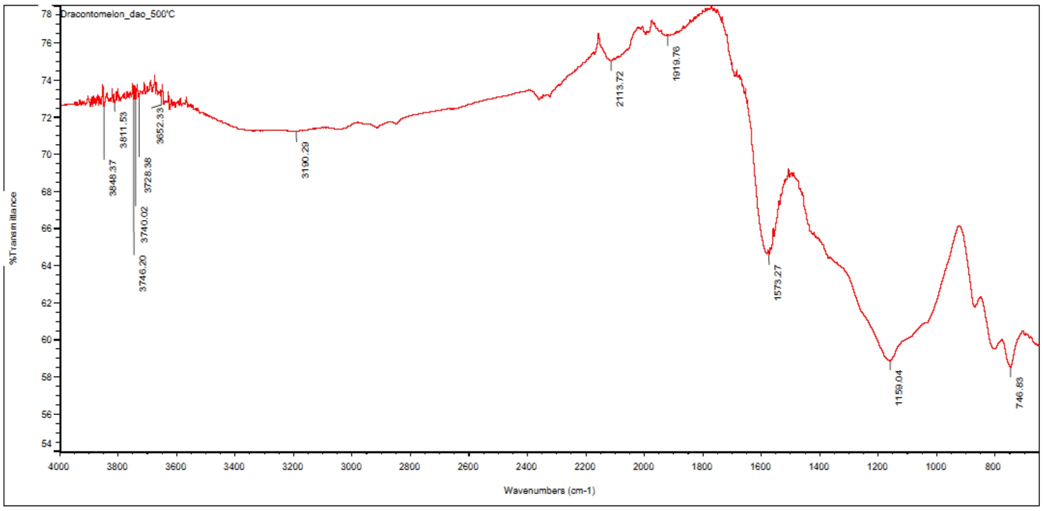

Figure 7 (b) FTIR analysis of Dracontomelon dao shell biocher at 500 °C

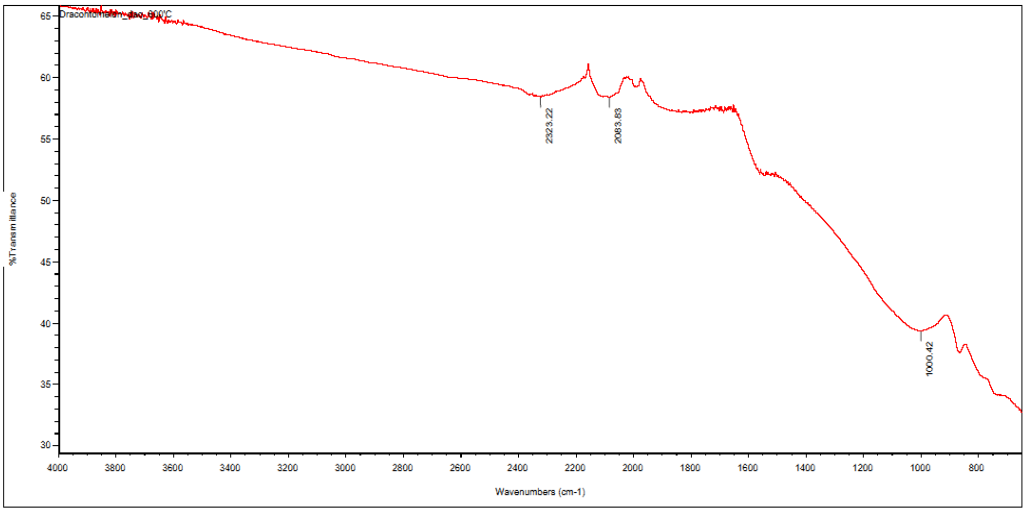

Figure 7 (c) FTIR analysis of of Dracontomelon dao shell biocher at 600 °C

Conclusion

The preparation and characterization of three biochars on different pyrolysis temperatures have been studied. According to XRD result, the biochar of three temperatures were found to be amorphous structure with little crystalline and they were matched with the peak of graphite, carbon, diamond and chaoite. The SEM images indicated that the average diameter of porous size becomes smaller when temperature increased. The FTIR spectrum analysis showed the functional groups decreased with the increasing of pyrolysis temperature. According to FTIR analysis, all of the absorption bands are due to hydroxyl group in cellulose, carbonyl groups of acetyl ester in hemicelluloses, and carbonyl aldehyde in lignin. By the three measurements on these three temperatures, the low temperature biochar types are more suitable for absorption area than the higher temperature biochar. The results highlighted the effect of pyrolysis temperatures on this three biochar present a simple, economical and environment-friendly method. According to such characteristics, it will be useful in the biochar application as soil amendment and absorption capacities. So the present work will be benefit in biochars for improving the growth and enhancing the renewable energy in Myanmar.

Acknowledgements

The authors would like to thank Dr Pho Kaung, Rector of University of Yangon for his kind permission to do this research paper.

I would like to express my sincere thanks to Professor Dr Khin Khin Win, Head of the Department of Physics, University of Yangon for her kind encouragement and permission to perform this research work.

I also would like to thank Professor Dr Aye Aye Thant, Professor Dr Myo Lwin, Professor Dr Yin MaungMaung, Professor Dr Than Zaw Oo, Department of Physics, University of Yangon, for their kind advice and suggestions for this research.

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