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# PREPARATION AND STRUCTURAL PROPERTIES OF PALM SHELL

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*Abstract*— **Bio-char can be produced by thermal conversion of biomass. Palm shells were obtained from palm fruits (palmira). They were air-dried to remove moisture. The dried palm shells were ground to become powder and heated at 600ºC, 800ºC and 1000ºC for 2 h respectively. After heating, bio-char was obtained. Structural properties of palm shell powder and bio-char were examined by X-ray diffraction (XRD). Scanning electron microscopy (SEM) was used to observe microstructure of bio-char. Properties such as hydration capacity, pH were also evaluated.**

*Index Terms*— **Biochar, XRD, SEM, Hydration capacity, pH.**

## I. INTRODUCTION

Today, researches all over the world are focusing the ways of utilizing industrial wastes. This utilization may be economical and may also be result in environmental pollution control [1-2].

Bio-char is the carbon-rich product obtained when plant biomass (agricultural waste) or animal biomass is subjected to heat treatment in an oxygen limited environment and is applied to soil as an amendment[3]. Bio-char is a relatively new term, yet it is not new substance. Through the forest and grass land fires, bio-char is deposited in the soil [4]. The properties of bio-char depend on biomass feedstock type, pyrolysis condition and duration of charring. Bio-char is also the most important by product of the pyrolytic process. It can be used as adsorbent for waste water treatment and other application [5]. Pyrolysis is the process of heating a biomass feedstock rapidly in the absence of oxygen, and then quickly condensing the resultant vapors into bio-oil, the desired product [6]. Bio-char can significantly improve soil physical quality bulk density water holding capacity. Due to differences in production, bio-chars do not possess similar properties even when derived from the same feedstock [7]. The solid bio-char can be used as a fuel in form of briquettes or as a char-oil, char-water slurry. Alternatively the bio--char can be upgraded to activated carbon and used in purification processes [8]. Palm shell can be used as the raw material for the preparation of activated carbon. They were produced by treating organic precursors at high temperature. This removes volatile components such as water, leaving void spaces which form the characteristics porous structure. Oil palm shell with particle size of 0.5 to 1.5 mm was treated with $ZnCl_2$ solution and pyrolyzed in two stages [9]. Activated carbons are some of the most widespread agent for the treatment and purification of water. They have high porosity [10]. Palm shell is a kind of agriculture waste and it is most available in many parts, in middle Myanmar. The objective of this work was to prepare and study characterization of bio-char from palm shell (*Borassas Flabellifer L*)

## II. EXPERIMENTAL PROCEDURE

Palm fruits were collected from Taungoo. The fruits were washed with fresh water to remove impurities such as dust. The shells are cut into small pieces. These shells were air-dried about one week. The dried shells were cut into smaller pieces. The palm shells obtained were ground and some were pyrolyzed in muffle furnace. The heating conditions used are 600ºC, 800ºC and 1000ºC for 2 h respectively. The shell powder and char are taken. XRD was used to detect whether the sample powder and bio-char were crystalline phase or amorphous structure. SEM was used to examine the morphology of the samples.

Five grams of bio-char was dispersed in fifty grams of distilled water with stirring. The mixture is boiled and then cooled down. The pH value is determined by meter. 5 g ($w_d$) quantities of bio-char at different temperatures were placed in 25ml capacity beakers respectively and 20 ml of distilled water was then added to each. The content was stirred with a glass stirring rod and the dispersions were allowed to stand for 24 hours. The excess water was water was removed by decanting and upturning. The weight of hydrated bio-char ($w_h$) was determined.

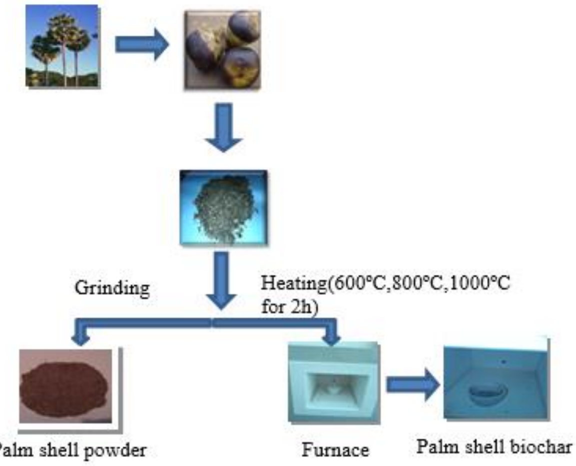


**Fig.1. Block diagram for experimental procedure of palm shell biochar.**

## III. RESULTS AND DISCUSSION

### *A. XRD Analysis*

The palm shell powder and bio-char were analyzed by XRD technique. The XRD spectra of palm shell powder and palm shell bio-char at 600 ºC, 800 ºC and 1000 ºC for 2h were shown in Fig.2 and Fig.3(a–c). From Fig.2, three diffracted peaks were observed. They were not perfectly identified. It could be said that palm shell powder was amorphous material with little crystalline. From Fig. 3(a), it was found that three diffracted peaks were formed and they were matched with the peaks of KCl. From Fig.3(b),the observed peaks were matched with the KCl peaks. From Fig.3(c), it was observed that four diffracted peaks were formed. Also, these peaks were matched with KCl peaks.

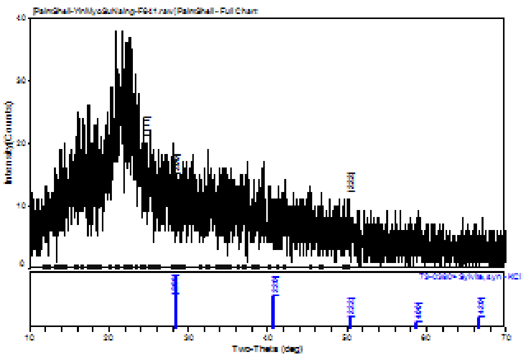

**Fig.2. The XRD pattern of palm shell powder**

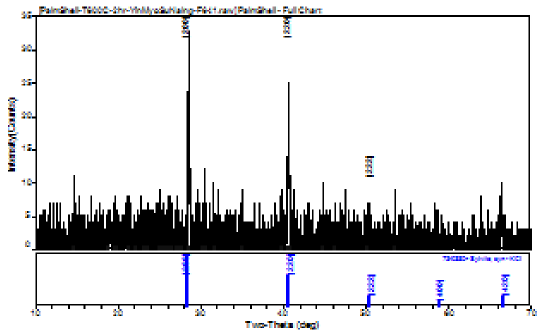

**Fig.3(a). The XRD pattern of palm shell bio-char at 600 °C for 2h**

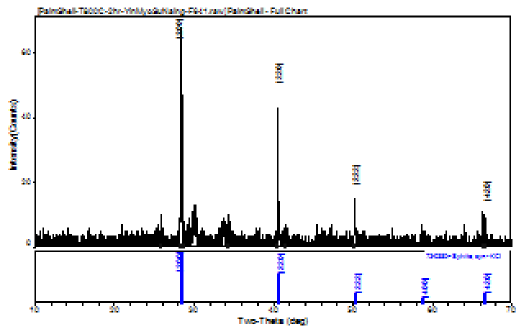

**Fig.3(b). The XRD pattern of palm shell bio-char at 800 °C for 2h**

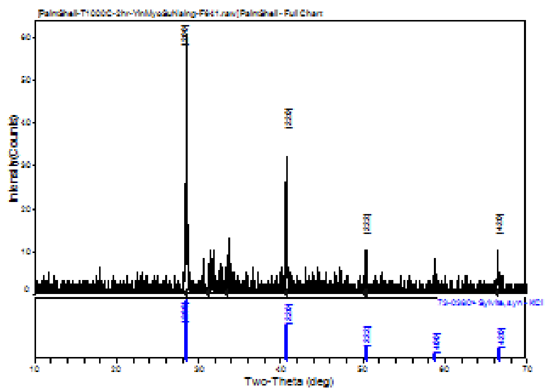

**Fig.3(c). The XRD pattern of palm shell bio-char at 1000 °C for 2h**

### *B. Structural Properties of Palm Shell Powder and Bio-char*

| *Plane (hkl)* | *FWHM (degree)* | *FWHM (rad)* | *2-theta* | *B(rad)* | *cosθ* | *Size(Å)* |
|---|---|---|---|---|---|---|
| 111 | 0.085 | 0.0015 | 24.535 | 0.0023 | 0.9772 | 601,95 |
| 200 | 0.153 | 0.0027 | 28.402 | 0.0042 | 0.9694 | 337.08 |
| 311 | 0.301 | 0.0053 | 47.736 | 0.0083 | 0.9145 | 181.64 |
| 222 | 0.211 | 0.0015 | 50.224 | 0.0023 | 0.9055 | 658.34 |

**TABLE I. RAW PALM SHELL POWDER**

| *Plane (hkl)* | *FWHM (degree)* | *FWHM (rad)* | *2-theta* | *B(rad)* | *cosθ* | *Size(Å)* |
|---|---|---|---|---|---|---|
| 111 | 0.678 | 0.0118 | 24.644 | 0.0186 | 0.9970 | 75.48 |
| 200 | 0.216 | 0.0038 | 28.521 | 0.0059 | 0.9692 | 238.83 |
| 220 | 0.237 | 0.0041 | 40.663 | 0.0065 | 0.9377 | 224.98 |
| 222 | 0.442 | 0.0077 | 50.219 | 0.0121 | 0.9055 | 124.92 |

**TABLE II. PALM SHELL BIO-CHAR (600 °C ) FOR 2H**

| **Plane (hkl)** | **FWHM (degree)** | **FWHM (rad)** | **2-theta** | **B(rad)** | **Cos θ** | **Size(Å)** |
|---|---|---|---|---|---|---|
| 200 | 0.181 | 0.0032 | 28.405 | 0.0050 | 0.9694 | 284.94 |
| 220 | 0.215 | 0.0038 | 40.545 | 0.0059 | 0.9380 | 247.90 |
| 222 | 0.290 | 0.0051 | 50.199 | 0.0080 | 0.9055 | 190.38 |
| 420 | 0.329 | 0.0057 | 66.638 | 0.0090 | 0.8356 | 181.87 |

**TABLE III. PALM SHELL BIO-CHAR (800 °C) FOR 2H**

| **Plane(hkl)** | **FWHM (degree)** | **FWHM (rad)** | **2-theta** | **B(rad)** | **Cos θ** | **Size(Å)** |
|---|---|---|---|---|---|---|
| 200 | 0.183 | 0.0032 | 28.501 | 0.0050 | 0.9692 | 281.88 |
| 220 | 0.166 | 0.0029 | 40.665 | 0.0046 | 0.9377 | 321.20 |
| 222 | 0.163 | 0.0028 | 50.351 | 0.0045 | 0.9050 | 388.93 |
| 420 | 0.138 | 0.0024 | 66.455 | 0.0038 | 0.8365 | 433.13 |

**TABLE IV. PALM SHELL BIO-CHAR (600 °C ) FOR 2H**

### *C. SEM Analysis*

Scanning electron micrographs for external morphology of palm shell powder and palm shell bio-char at temperatures 600ºC, 800ºC and 1000ºC for 2h were shown in Fig 4 and Fig.5(a-c). From Fig.4, the porous nature had not observed in the native palm shell. From Fig. 5(a), it was found that the palm shell bio-char had porous nature with microporous structure. From Fig.5(b), the bio-char has porous nature and it was found distributed uniformly. From Fig.5(c), the pore sizes were found to be smaller, the grains were smaller and uniformly distributed.

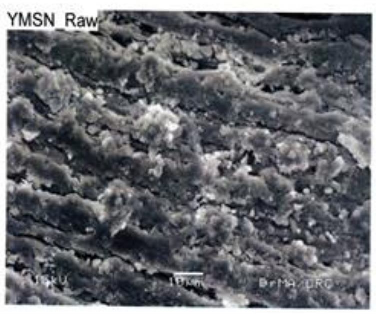


**Fig.4. SEM image of raw palm shell powder**

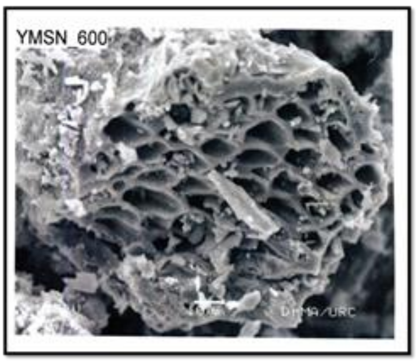


**Fig.5(a). SEM image of palm shell bio-char at 600 °C**

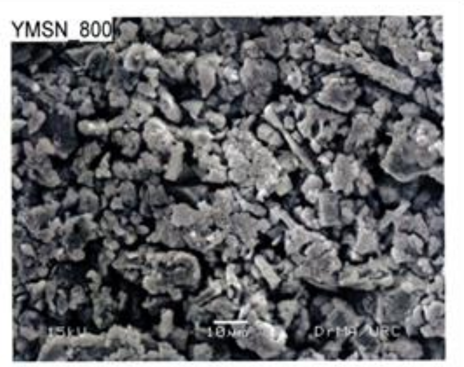


**Fig.5(b). SEM image of palm shell bio-char at 800 ºC for 2 h**

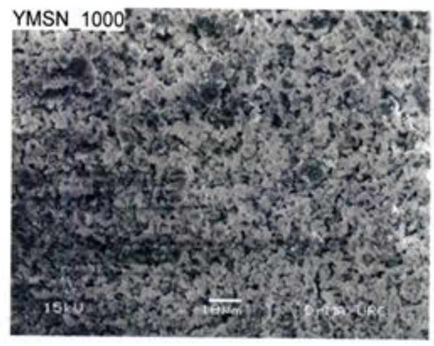


**Fig.5(c). SEM image of palm shell bio-char at 1000 ºC for 2 h**

*D. Bio Char Yield*

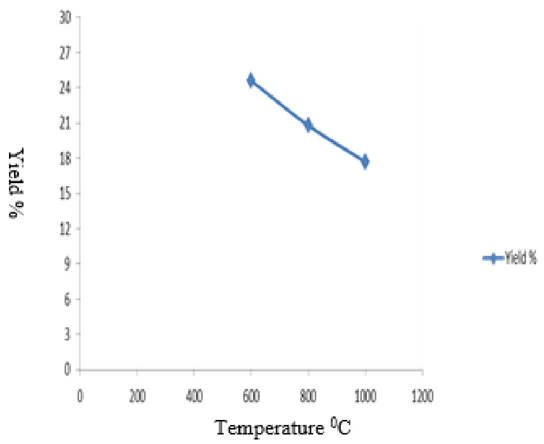


**TABLE V. HYDRATION CAPACITY OF BIOCHAR**

$$Hydration = \frac{w_h - w_d}{w_d} \times 100 \ (\%)$$

Where $w_h$ = hydrated mass
$w_d$ = dried mass

| *Temperature* | *%Hydration* |
|---|---|
| 600ºC | 220 |
| 800ºC | 150 |
| 1000ºC | 133 |

**TABLE VI. PH OF BIOCHAR**

| *Temperature* | *PH* |
|---|---|
| 600 | 11.9 |
| 800 | 12 |
| 1000 | 12.2 |

## IV. CONCLUSION

The XRD spectra and SEM images of palm shell powder and bio-char were studied. As a result of XRD, the palm shell powder and bio-char at different temperatures (600 ºC, 800 ºC and 1000 ºC) were matched with KCl. From SEM images, Palm-shell bio-char could be said that it has porous nature. It can be said that bio-char has water retention ability. Bio-char yield decreases as the heating temperature increases. Bio-char has pH value of 12 and can be used to reduce soil acidity. Hydration capacity is average of 170. The conditions for producing bio-char with useful properties and bio-char application will be studied further.

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