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PRODUCTION OF CHAR FROM COCONUT DREGS

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ABSTRACT

Coconut dregs is a waste produced by pressing process of fresh coconut kernel. Large quantity of the dregs produced by fresh coconut milk seller is an advantage to be exploited as a raw material for certain products. In this study, coconut dregs was used to produce char with different time and temperature of carbonization, i.e. 2, 3, and 4 hours and 300, 400, 500 and 600 °C respectively. It was found that temperature and time of carbonization have a significant effect on the yield and quality of char. The proximate analyses was also conducted to determine moisture, ash, volatile matter, and fixed carbon content. Detailed design of the batch operating kiln and its operational procedure are also presented in this paper. The results obtained show that yield of the char produced ranges from 18 to 46 percent from original weight of the dregs. The highest fixed carbon of the char obtained at temperature 600 °C and time 4 hours with 79.43 %, while moisture, volatile matter and ash content are 3.0 8 %, 17.11 %, and 0.38 % respectively. The char produced in powder formed exhibit slightly porous structure as shown by BET surface area, iodine number and methylene blue number.

Key words: *Coconut dregs, carbonization, temperature, residence time and surface properties.*

INTRODUCTION

In the past, a large portion of coconut products in this country after making allowances for fresh consumption, were processed into copra for crushing and oil extraction. Charcoal is defined as a solid produce that content about 75 to 80 % of carbon produced by heating carbonaceous material such as cellulose, wood, peat and coal of bituminous of lower rank at 500°C to 600°C in the low quantity of air (3), (4). A process in the manufacturing of charcoal is known as carbonization process. The process involves thermal decomposition of carbonaceous materials by eliminating non-carbon species and producing a fixed carbon mass and rudimentary pore structure.

Any material that contains high amount carbon and low in inorganic compound can be used to produce charcoal (5). In this experiment, the raw material used to produce charcoal was the coconut dregs, which can be found in small granule form that produced by squeezing of coconut kernel.

Determination of the quality and yield of the carbonized products involve important parameters such as the heating rate, final temperature, soaking time during the final temperature and the nature and also the physical state of the raw material (9). Carbonization process involved thermal decomposition of the carbonaceous material, eliminating non-carbon species and producing a fixed carbon mass and a rudimentary pore structure (7).

Two important stages in this process are carbonization process and softening period. Temperature control has an important bearing on the type of char obtained before the char begins to harder and shrink. The shrinkages play an important role in the development of porosity in the char. During the softening stage, temperature rise should be very slow so that the gases could escape through the pores in the sample without collapse or deformation (7).

The quality of the charcoal produced is differentiated by the height of the kiln being used. It was found that different area of the kiln from the top to the bottom could produce different quality of char in terms of volatile matter, ash, moisture and fixed carbon content. It is important to study the characteristic of carbonized product and to identify the potential of the raw material in order to produce wide range of charcoal. The main objective of this experiment is to study the suitability of coconut dreg to produce high quality of char.

EXPERIMENTAL PROCEDURE

Experimental Rig

Figure 1 shows the experimental rig for char production. Gas fuel (LPG) was used to heat the sample container by burning the process. All processes were manually controlled. Samples were loaded and unloaded through the top of the ceramic sample container.

Experimental procedure

The coconut dreg was dried in an oven at 100 ± 10°C for 3 hours to remove moisture in order to get the net weight of dried sample. A weight of the sample was poured into the sample container and then carbonized by burning of the gas fuel until it reach 300 °C for 2 hours carbonization time. The burning process then stopped and the char produced was unloaded when the temperature reached to the ambient condition. The char produced then weighed immediately to determine the yield. The char then subjected to the characterization methods. The same procedure was repeated for 3 and 4 hours carbonization time. The same set-up then applied for another samples.

Char characterization

Proximate analyses to determine the volatile matter, moisture content, ash content and the fixed carbon content in charcoal produced was conducted based on the British Standard, BS 1016: part 3, 1973.

While porosity of the char produced was determined using methylene blue number and iodine number based on the MS 873 (1984) and ASTM D 4607 (1990) respectively. Methylene blue number is defined as the number of cubic centimeters of standard methylene blue solution decolorized by 0.2 gram of activated carbon (dry basis). While, iodine number is defined as the number of milligrams of iodine adsorbed by 1 gram of sample from an aqueous solution when iodine concentration of the residual filtrate is 0.002 N.

Surface area of the samples was determined based on the standard method, i.e. Brunnauer-Emmet-Teller (*BET*) using nitrogen gas as the adsorbent. This method is a build-in technique available in the porosimeter of Micromeritics ASAP 2000.

RESULTS AND DISCUSSION

Figure 2 shows the yield obtained by the carbonization with different time and temperature. The yield decreased when the temperature and time of carbonization increased. The highest yield was obtained at 2 hours carbonization and 300 °C with 46 %, while the lowest is 18% obtained at 4 hours carbonization for 600 °C. These results comply with the proximate analysis of the samples as shown by Table 1. The highest volatile was obtained at the lowest time and temperature of carbonization. The content of volatile compound has an important role in yield obtained as well the porosity of the samples as shown by figures 3, 4 and 5 for methylene blue number, iodine number and surface area respectively. Moisture content of the entire sample was found to be less than 6.01 %. However, fixed carbon of the char increased with the increasing of time and temperature of carbonization. From the Figure 2, the yield of char obtained closes each other at 400 °C regardless the carbonization time.

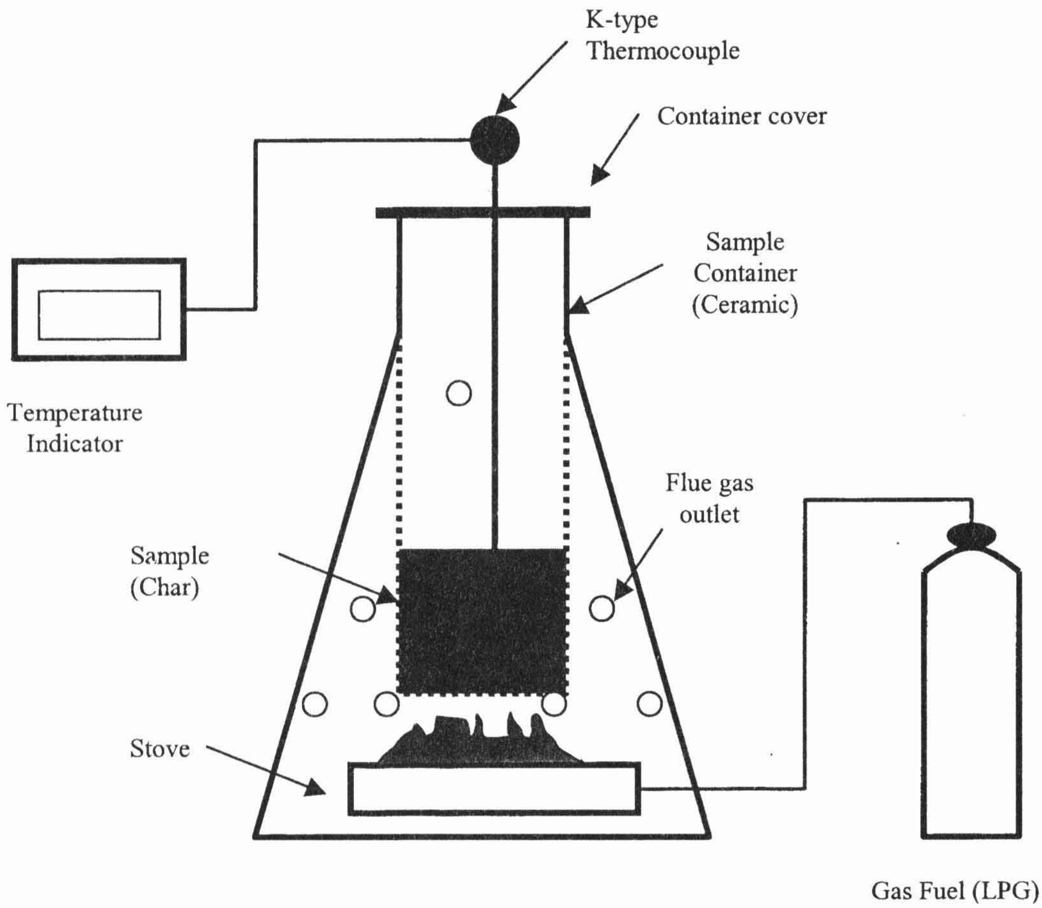

Figure 1: Experimental Rig (Kiln) for Char Production

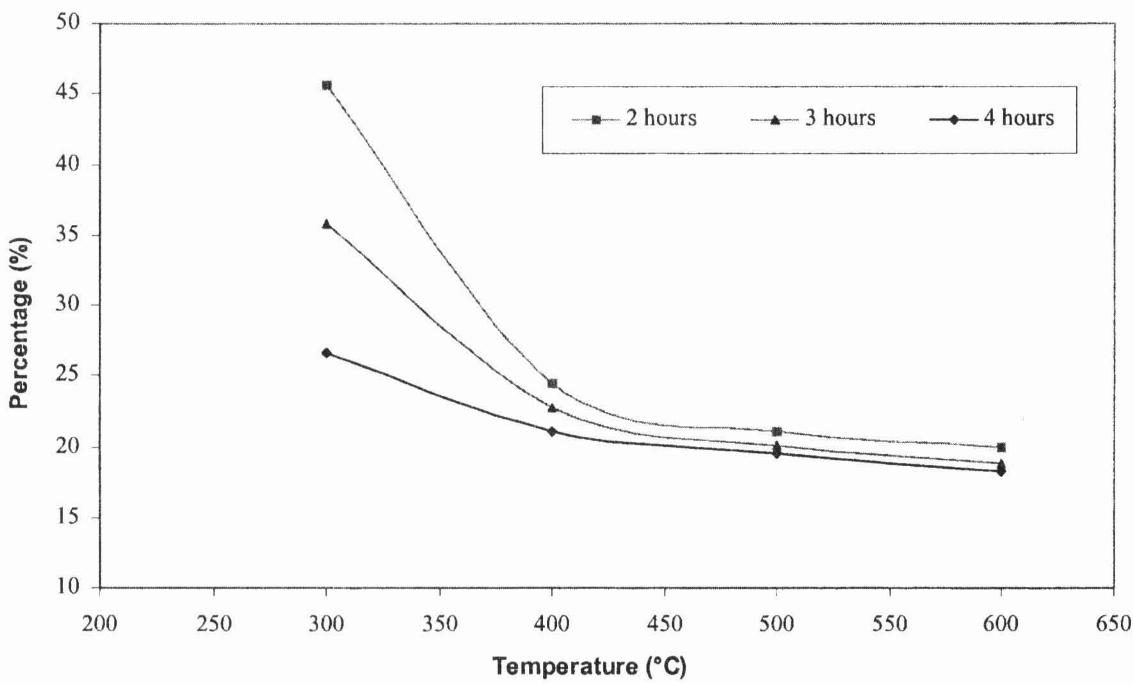

Figure 2: Yield of char versus carbonization temperature

Table 1. Results of proximate analysis of char

Parameters		Moisture Content	Ash	Volatile Matter	Fixed Carbon
Temp (°C)	Time (Hrs)	(%)	(%)	(%)	(%)
300°C	2	6.01	0.25	31.67	62.07
	3	5.81	0.25	29.78	64.16
	4	5.59	0.26	27.88	66.27
400°C	2	5.32	0.29	30.83	63.56
	3	5.18	0.30	28.21	66.31
	4	5.02	0.30	25.74	68.94
500°C	2	4.89	0.31	27.11	67.69
	3	4.42	0.32	24.48	70.78
	4	3.81	0.34	20.51	75.38
600°C	2	3.49	0.35	23.86	72.30
	3	3.22	0.36	20.83	75.59
	4	3.08	0.38	17.11	79.43

Methylene blue number, iodine number and surface area of the chars, which are related to the adsorption power, increased with increasing of the time and temperature of carbonization. The higher amount of volatile released could create more pores in the char, thus increase the adsorption capacity. Since the ash content in the samples considered low, it is reasonable to say that its role in the adsorption capacity is insignificant. As the char produced in powdered form, its adsorption capacity should be higher than the char in granular form even though the same carbonization parameters employed. Besides that, heat distribution could be higher in coconuts dregs during carbonization that found to be completely devolatilized at 450 °C as compared to palm shell and fibers that found to completely devolatilized at 600 °C (8). Different types of volatile could be released by the coconut dregs as compared to the palm oil based materials as shown by the different temperatures. Unfortunately, the volatile compounds were not determined in this research.

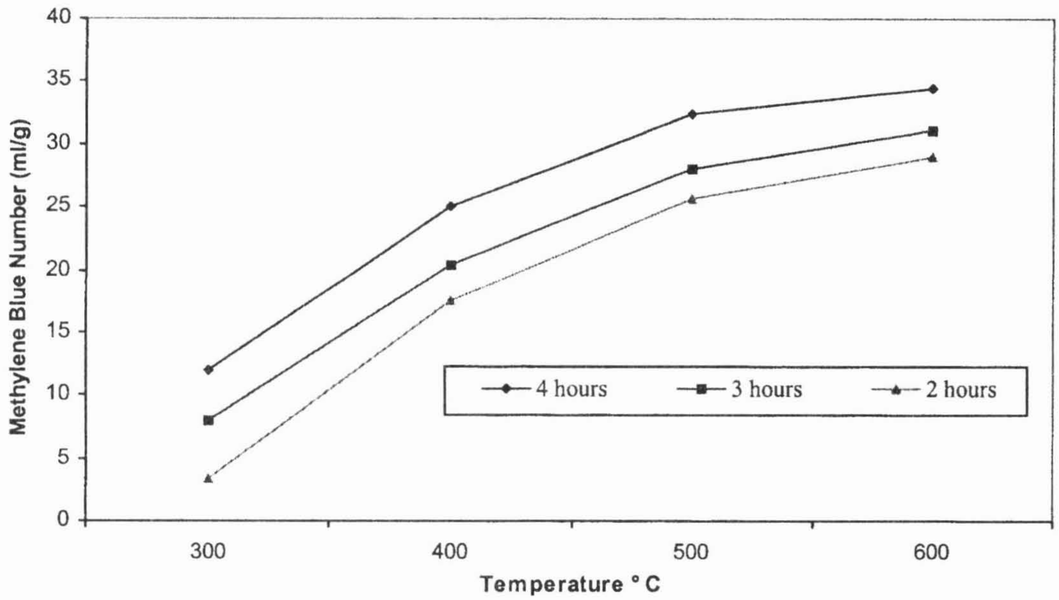

Figure 3: Methylene blue of chars versus carbonization temperature

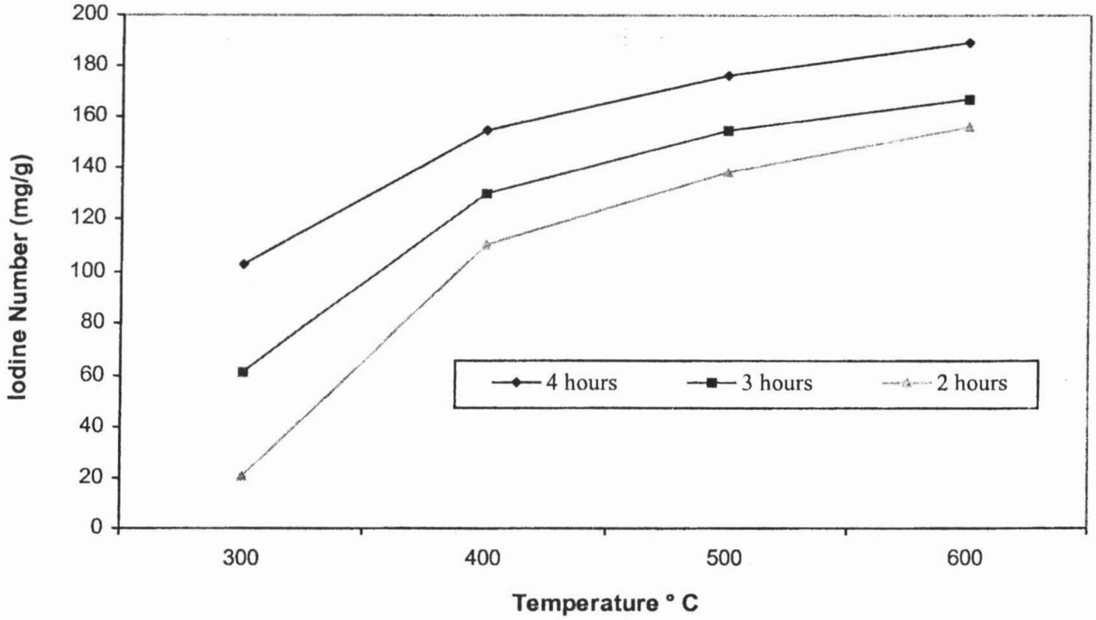

Figure 4: Iodine number of chars versus carbonization temperature

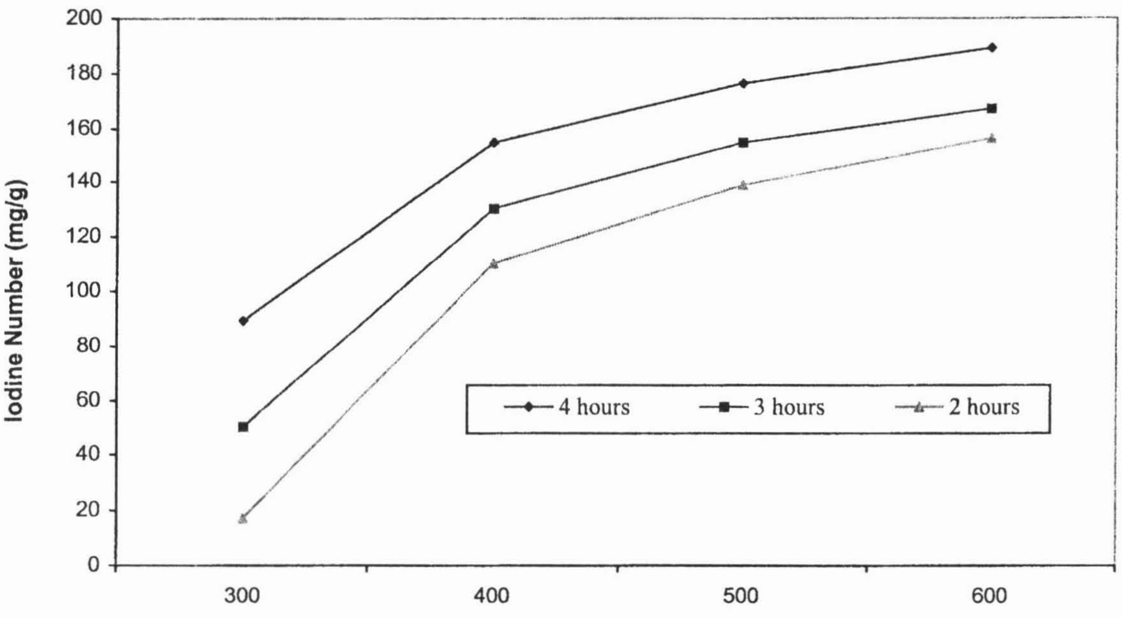

Figure 5: Specific surface area of chars versus carbonization temperature

CONCLUSIONS

The coconut dregs is suitable to produce char. The high temperature at 600°C and time at 4 hours of carbonization, produce high adsorption capacity of the char. It was found that coconut dregs were completely devolatilized about 450 °C.

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