Determination of Shell Charcoal Yield of Different Coconut Varieties in Sri Lanka Under Optimum Temperature Condition

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Introduction

Due to improper management, inefficient use of resources, low quality inputs and production procedures, charcoal production in Sri Lanka has become a less profitable industry, which pollutes the environment while causing health problems to the workers as well as to society. In Sri Lanka, charcoal is mainly produce using traditional methods. Therefore, the efficiency of these methods and quality of the charcoal produces are low compared to modern-improved technologies. As a developing country, it is difficult to adopt these improved methodologies due to lack of capital and other facilities. The study was carried out to determine (i) Optimum temperature condition for carbonization of Coconut shells and, (ii) the variety that gives the highest charcoal yield.

Methodology

To determination of optimum carbonization temperature, Coconut shells were oven dried for two days at 70 ^{0}C, crushed and passed through 5mm sieve. Samples were weighed and placed in a muffle furnace at carbonization temperatures of 200,250, 300,350,400,450,500,550 C for different resident time periods 5, 10, 15,20,25,30 minutes respectively. The charcoal yield was weight in each occasion. Quality parameters such as volatile matter, ash content, moisture content and fixed carbon content of the charcoal was determined. The temperature and time, at which to weight charcoal yield with best quality produced were taken as the Optimum temperature and time. Which referred to the one, which gave the highest amount of charcoal with particular quality parameters (moisture content, ash content and volatile matter content) under optimum carbonization conditions.

Results and Discussion

Optimum carbonization temperature - according to the figure 1, shell charcoal could not be produced at 200 C^0 and 250 C ^{0}temperature for 30 minutes resident time. It was shown that charcoal could be produced at 250 C^0 in two hours resident time. This is not considered wastage of energy and high cost of production. When the temperature was increased to 400 ^{0}C and further more ash produced. The present work showed that the most effective carbonization temperature was 350 C^0 and resident time 15 minutes when only the yield was concerned. Therefore, all charcoal samples produced at 350 C ^{0}were analyzed for the quality parameter requirements given by Sri Lanka Standards 571 1982.

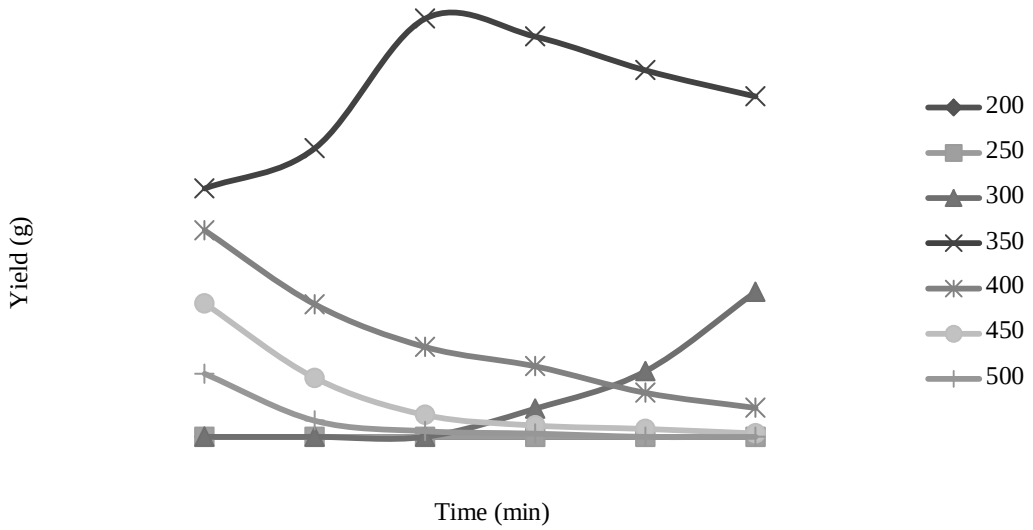

Figure 1. Charcoal yield at different temperature and resident time combinations

Table 1. Quality parameters for the charcoal produced at 350 ^{0}C.

Time (min)	Charcoal yield (%)	Volatile matter content (%)	Ash content (%)
15	40.73	17.94	0.28
20	38.67	16.81	0.37
25	35.65	16.53	0.39
30	32.79	16.05	0.48

All the above mentioned samples did not exceed the SLS quality requirements in both volatile matter as well as the ash content (See table 01). There was a significant difference *(P<0.5)* in volatile matter content between samples carbonized for 15 minutes and other three samples. But, there was no significant difference (*P*<0.05) between 20, 25 and 30 minutes samples. When the ash content was considered, there was no significant difference *(P<0.05)* between all four samples. Cost calculation showed that, the most cost effective sample was the sample carbonized at 350 ^{0}C for 15. Thus, it was decided to take 350 ^{0}C of 15 minutes resident time as the optimum conditions for carbonization of coconut shells. At present under Sri Lankan conditions, charcoal yield (See table 02) obtained from conventional and improved methods lays between 27-32% of the shell weight.(Ceylon Annual Report, 2010). However, project results confirm that, this level can be increased >40% under selected conditions.

Table 2. Charcoal yield of different Coconut varieties at 350 ^{0}C and 15 min resident time.

Coconut Variety	Charcoal Yield (%)
CRIC 60	40.31
CRIC 65	39.7
Kapruwana	46.59
CRISL 98	41.27

The results showed that, all Coconut varieties given the yield of charcoal over the yield obtained from all other production methods, currently practiced in Sri Lanka. It was also shown that

Kapruwana variety gave the highest amount of charcoal (>46%) with 0.67, 14.83 and 84.5% of ash, volatile matter and fixed carbon, respectively.

Conclusions

Optimum parameters for effective and full carbonization of Coconut shells included carbonization temperature 350 ^{0}C and carbonization resident time 15 minutes. One hour cooling time in a closed chamber with a good waste removal system.

Kapruwana was variety that gave the best charcoal yield, which included about 46.59% charcoal out of the shell weight.

The chemical quality parameters of charcoal muffle furnace produced under the given optimum conditions are within SLS standards and better than the charcoal produced from the traditional and the improved methods currently practices in Sri Lanka

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