CHARCOAL PRODUCTION FROM DISCARDED TENDER COCONUT SHELLS – AN EFFECTIVE WAY OF RECYCLING.

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ABSTRACT

Tender coconut water is a natural drink which has high demand worldwide, particularly in tropical countries like India. However, in many places the tender coconuts shells (TCSs) are simply discarded which create a nuisance in terms of mosquito breeding centre and waste management problem. A study has been conducted to recycle them into charcoal and its effectiveness as a fuel.

Proximate Analysis

Five (5) charcoal pieces were chosen randomly from the harvested charcoals and crashed into powder for further analysis. The 6mg of powder was taken in the laboratory and analysed for moisture content (%), volatile organic matter, fixed carbon, and ash content using the SDT Q600 V20.9 Build 20 instrument. According to Raphael and Zuvena, (2015) and Jagbemi et al., (2014), the proximate analysis of the charcoals was done using the following formula:

M (%) = \( \frac{\text{mass of air dry samples} - \text{mass of sample after drying at 100°C}}{\text{mass of air dry samples}} \times 100 \)

VOM (%) = \( \frac{\text{mass of sample at 150°C} - \text{mass of sample at 550°C}}{\text{mass of sample at 150°C}} \times 100 \)

Ash content (%) = \( \frac{\text{mass of residue (mass of sample at 850 °C)}}{\text{mass of sample at 150°C}} \times 100 \)

Fixed Carbon = 100 – (AC + VOM)

Table 1: Physical characteristics/ nature of charcoal produced from TCSs

<table>
<thead>
<tr>
<th>Parameters</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>Average± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonization in hours</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72±0</td>
</tr>
<tr>
<td>Dry material</td>
<td>225</td>
<td>228</td>
<td>216</td>
<td>240</td>
<td>220</td>
<td>225.8±9.18</td>
</tr>
<tr>
<td>Charcoal produced in gr</td>
<td>87.3</td>
<td>87.55</td>
<td>83.8</td>
<td>90.24</td>
<td>82.76</td>
<td>86.33±3.04</td>
</tr>
<tr>
<td>Charcoal density</td>
<td>0.31</td>
<td>0.286</td>
<td>0.264</td>
<td>0.317</td>
<td>0.29</td>
<td>0.29±0.02</td>
</tr>
<tr>
<td>Charcoal yield in %</td>
<td>38.8</td>
<td>38.4</td>
<td>38.8</td>
<td>37.6</td>
<td>37.6</td>
<td>38.24±0.61</td>
</tr>
</tbody>
</table>

Results and Discussion

The results in table 1 and 2 shown the physical characteristics and quality of tender coconut shell charcoals based on the production process.

In nature, the color of charcoal produced is uniformly black and C1, C2, C3, C4, C5 represent charcoal samples selected randomly for analysis. It was found that the average density is 0.291g/Cm3, this may be attributed to the raw material used in terms of size and concentration, sources (soil), maturity and hardness. The finding of Madakson et al., (2012) shown that the density of the coconut shell was 2.05g/Cm³.

The charcoal production average calculated was 86.33g from 225.8g piece of dried raw material and the yield determined was found to be 38.2%. The yield of charcoal was influenced by some factors like raw material, weather, and climate, carbonization condition, among others (Kwon et al., 2009) and vary in the range of 25-30% of the dry weight of shells (Salman, 2016; CDB, 2017).
Table 2: Results of the proximate analysis showing the quality of charcoal

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>Average± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content in %</td>
<td>8.2</td>
<td>8.25</td>
<td>8.15</td>
<td>8.32</td>
<td>8.1</td>
<td>8.20±0.08</td>
</tr>
<tr>
<td>Volatile Organic Matter in%</td>
<td>23.8</td>
<td>25.4</td>
<td>24.7</td>
<td>25.2</td>
<td>24.6</td>
<td>24.74±0.6</td>
</tr>
<tr>
<td>Fixed Carbon Content %</td>
<td>63.8</td>
<td>62.1</td>
<td>62.9</td>
<td>62.16</td>
<td>63.08</td>
<td>62.8±0.5</td>
</tr>
<tr>
<td>Ash content in %</td>
<td>4.2</td>
<td>4.25</td>
<td>4.25</td>
<td>4.32</td>
<td>4.22</td>
<td>4.25±0.04</td>
</tr>
<tr>
<td>Ash Dry</td>
<td>4.57</td>
<td>4.63</td>
<td>4.62</td>
<td>4.71</td>
<td>4.59</td>
<td>4.62±0.05</td>
</tr>
<tr>
<td>Fixed Carbon Dry</td>
<td>69.51</td>
<td>67.69</td>
<td>68.49</td>
<td>67.79</td>
<td>68.65</td>
<td>68.43±0.73</td>
</tr>
<tr>
<td>Volatile Dry</td>
<td>25.92</td>
<td>27.68</td>
<td>26.89</td>
<td>27.75</td>
<td>26.76</td>
<td>26.95±0.69</td>
</tr>
</tbody>
</table>

The results revealed that the moisture, volatile matter, fixed carbon and ash content for TCSCs produced were 8.2%, 24.74%, 62.8% and 4.62% respectively, which are in the range of a good charcoal quality. Several researches have been conducted on charcoal application; it was found that charcoals should present volatile matter contents of 20–25% for steel use (Santos, 2008). The quality analysis of charcoal produced by Botrel et al. (2007) shown 25.50% of volatile matter, 74.25% of fixed carbon, and 0.25% of ash. The work done by Neves et al., (2011) shown that the average levels of volatile, fixed carbon, and ash were 18.92, 80.29, and 0.80% respectively.

![Figure 2: Heat flow of charcoal produced](Image)

Fig 2: Heat flow of charcoal produced

The tender coconut shells charcoal have advantages in terms of greater heat intensity, cleanliness and convenience in use. Based on analysed samples, the charcoals with lower ash content value has invariably higher heating values and the one of higher ash content has lowest heating value. The high moisture content also influences the low value of the calorific values (Mizero et al., 2014). The presence of high mineral matter in substance material cause high ash content and contributes to the reduction of charcoal heating value (Mizero et al., 2014; Tsoumis, 1991).

Conclusion

The charcoals generated from tender coconut shells by the Kiln method were found to be very effective strategy for recycling. The moisture, volatile organic matter, ash content and fixed carbon values of that charcoal produced are in range of normal biofuel. On the environmental front, the TCSCs production could be encouraged to reduce the huge volume of coconut waste disposed in and around the environment and to reduce deforestation for the purpose of charcoal production.

References