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Physical Characterisation and Surface Morphology of Hybrid Oil Palm Trunk and Corncob Biofuel Briquettes with Paper Pulp Waste as Binder

Pubeshwaran Yuvarajan[1], Mohamad Faiz Zainuddin[1]*, Kpalo Sunday Yusuf[2], Latifah Abd Manaf[1], Ahmad Muhaimin Roslan[3], and Nik Nor Rahimah Nik Ab Rahim[1]

[1]Department of Environment, Faculty of Forestry and Environment, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2]Faculty of Environmental Sciences, Nasarawa State University, Keffi 961101, Nigeria
[3]Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ABSTRACT

A blend of oil palm trunk (OPT) waste with corncob (CC) is proposed to produce solid biofuel briquettes. This study focus on characterising the performance of OPT and CC blend briquettes in terms of physical properties and surface morphology. The 100% OPT and 100% CC briquettes were considered as the control samples, while the blend of 50% OPT and 50% CC (OPT/CC) briquettes was considered as the test samples. Physical characterisations included moisture content (MC), water resistance (WR), density, and shatter index. Surface morphology was examined using a Scanning Electron Microscope (SEM) to observe and compare the microstructures of the samples under 50×, 100×, and 300× magnifications. The CC samples possess a higher MC (10.24%), lower WR (86.20%), and lower density (0.35 g/cm^3) than OPT samples (MC = 9.75%, WR = 93.20%, density = 0.43 g/cm^3). Observations from the SEM uncovered the presence of large cavities and pores for the CC samples and the test samples, which was largely missing from OPT samples. These observations confirmed the results from physical characterisation. Samples with large cavities tend to store more water, which leads to higher moisture content, lower water resistance, and lower density, which are undesirable qualities for briquettes.

Keywords: Briquettes, corncob, oil palm trunk, physical characterisation, surface morphology

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E-mail addresses:
pubesh12@gmail.com (Pubeshwaran Yuvarajan)
z_faiz@upm.edu.my (Mohamad Faiz Zainuddin)
kpalosy@nsuk.edu.ng (Kpalo Sunday Yusuf)
latifahmanaf @upm.edu.my (Latifah Abd Manaf)
muhaiminroslan@upm.edu.my (Ahmad Muhaimin Roslan)
rahimah_rahim@upm.edu.my (Nik Nor Rahimah Nik Ab Rahim)
* Corresponding author

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INTRODUCTION

Oil palm trunk (OPT) remains the least utilised waste for bioenergy production due to its lack of availability and accessibility in the oil palm fields. Therefore, a blend of OPT with other biomass waste such as corncob (CC) is proposed to solve this issue. The physical, mechanical, chemical, and combustion properties of OPT/CC blend briquettes were thoroughly investigated in Kpalo et al. (2020, 2021). Past investigations revealed that the OPT/CC briquettes performed as well as other biomass waste briquettes such as coffee husk, rice husk, rice bran, rice straw, sawdust, neem powder, pine needle, and banana waste.

However, the surface morphological assessment of the OPT/CC blend briquettes is yet to be covered. Surface morphology is essential to observe the fragmented microstructure of biomass briquettes (Gan et al., 2021). These observations are needed to explain the findings reported on the physical properties of OPT/CC blend briquettes, namely moisture content, water resistance, density, and shatter index (Kpalo et al., 2020, 2021).

METHODOLOGY

The samples were prepared, and characterisations were conducted based on the methods explained by Kpalo et al. (2020, 2021). The 100% OPT and 100% CC briquettes were considered as the control samples, while the blend of 50% OPT and 50% CC (OPT/CC) briquettes was considered as the test samples. The microstructures of the briquettes were examined with Scanning Electron Microscopy (SEM) at the Material Characterisation Laboratory, Faculty of Engineering, University Putra Malaysia (UPM) with 50×, 100×, and 300× magnifications operating at an accelerating voltage of 10 kV.

RESULTS AND DISCUSSION

Table 1 shows that CC briquettes possessed the highest moisture content, followed by the OPT/CC and the OPT briquettes. In contrast, the CC briquettes exhibited the lowest water resistance, followed by the test and the OPT briquettes. In terms of density, the CC briquettes were the lowest among all samples, followed by the test and the OPT briquettes. On the other hand, the CC briquettes recorded the highest shatter index compared to the test and the OPT briquettes. However, the LSD analysis revealed that no significant differences between the moisture content and the shatter index of all control and test briquettes. Nevertheless, significant differences were observed between the water resistances and the densities of the briquettes.

SEM images in Figures 1-3 uncovered the presence of large particles of OPT and CC biomasses in all briquette samples. This observation was expected due to the application of low densification pressure (< 7 MPa) to form the briquette cakes. Figures 1-3 show

Table 1
Physical quantifications of the OPT/CC samples and the Least Significant Difference (LSD) test

Parameter	CC + binder (100% CC)	OPT + binder (100% OPT)	CC + OPT + binder (50% CC, 50% OPT)
Moisture content (%)	10.24[a]	9.25[a]	9.75[a]
Water resistance (%)	86.20[b]	93.20[a]	88.30[b]
Density (g/cm^3)	0.35[a]	0.43[c]	0.39[b]
Shatter index (%)	99.20[a]	99.05[a]	98.16[a]

Note. Means with the same letter(s) in a row for each parameter are not significantly different ($P < 0.05$)

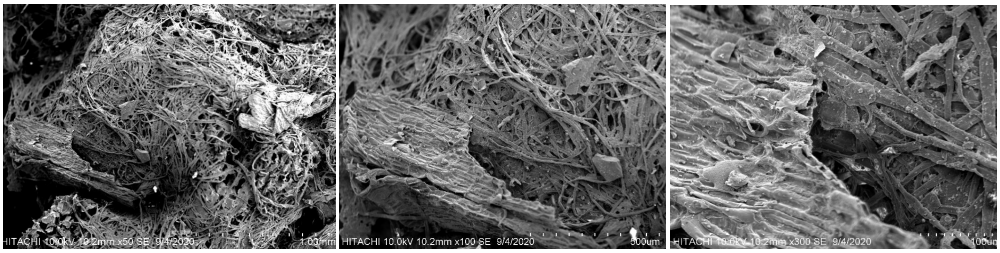

Figure 1. SEM images of CC briquettes (left: 50×, center: 100×, right: 300×)

Figure 2. SEM images of OPT briquettes (left: 50×, center: 100×, right: 300×)

Figure 3. SEM images of OPT/CC hybrid briquettes (left: 50×, center: 100×, right: 300×)

long fibres whichare thought to be wastepaper fibers. Large cavities found for the CC and the hybrid briquettes may explain high moisture contents, low water resistances and low densities recorded for both briquettes (Table 1). The presence of large cavities indicates that higher porosity in these briquetteswhich increases the capacity to absorb more water compared to OPT the briquettes.

CONCLUSION

The CC and hybrid briquettes exhibited higher moisture contents, lower water resistances, and lower densities compared with OPT briquettes. SEM analysis revealed the presence of large cavities in both CC and OPT/CC samples, which suggested high porosities for both briquettes. High porosity leads to high moisture contents, reduce water resistances, and lower densities of both samples. In addition, large particles of biomass and wastepaper pulp fibres were also observed in both samples.

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