# Charcoal Properties of Malaysian Bamboo Charcoal Carbonized at 750 °C

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The carbonization of five Malaysian bamboo species, namely *Bambusa vulgaris, Dendrocalamus asper, Gigantochloa hasskarliana, Gigantochloa levis*, and *Schizostachyum brachycladum*, was conducted to investigate the charcoal properties and compare the quality of bamboo charcoal produced based on proximate analysis. Carbonization at 750 °C using a modified Iwasaki steel drum kiln was successful for all bamboo species. Bamboo morphological features varied and basic density increased with culm height. A charcoal yield of more than 30% was recorded in all bamboo species except for *B. vulgaris* and *D. asper*. Charcoals made from *D. asper* and *G. hasskarliana* could serve as the alternative raw material for charcoal production in charcoal industries due to their low moisture, low volatile matter, low ash, and high fixed carbon content. All species had a mean gross calorific value between 24.4 and 29.2 MJ/kg. Among different culm sections, the bottom section produced the best quality charcoal. The charcoal quality from all species was of acceptable quality for domestic use.

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## INTRODUCTION

Bamboo is among the earliest raw materials utilized by humankind for various purposes, and it is classified under non-timber forest products. With a total of 1,642 species belonging to 123 genera (Vorontsova *et al*. 2016), approximately 3.2% of the world's total forest area is covered with bamboo. In 2019, global bamboo production and consumption were valued at USD 72 billion, and this value is expected to increase to USD 98 billion per year by 2026 (INBAR 2021). Almost 900 species, approximately 60% of bamboo species globally, are found in Asia (Liu *et al*. 2018a; Xu *et al*. 2020). There are 70 bamboo species spread across Malaysia in the Peninsular (50 species), Sabah (30 species), and Sarawak regions (20 species) (Wong 1989).

Bamboo plants are utilized for food, handicraft, construction, and industrial purposes (Chaowana and Barbu 2017). Various bamboo products are exported, including articles of daily use, kitchenware and tableware, construction materials, furniture, woven bamboo products, shoots, bamboo charcoal, and many more. The three largest product exports are bamboo articles of daily use (USD 798 million), bamboo tableware and kitchenware (USD 680 million), and bamboo shoots (USD 295 million) (INBAR 2019).

In Malaysia, industrial-grade charcoal is manufactured typically from mangrove woods (commonly *Rhizophora apiculata* and *Rhizophora mucronata*). With the increasing concerns about the availability of mangroves and the environmental sensitivity of