Optimization of pyrolysis conditions for char production from rice husks and its characterization as a precursor for production of activated carbon

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ABSTRACT:
Response surface methodology was employed to optimize pyrolysis conditions for production of char with maximum yield, fixed carbon content, and with minimum ash content from Uganda's New Rice for Africa (NERICA) 1 rice husk variety. The aim was to obtain rice husk char with more suitable properties as an activated carbon precursor. Mathematical models were developed to explain the relationships between the experimental responses and the pyrolysis parameters of temperature (400–600 °C), heating rate (10–25 °C min−1), and heating period (60–120 min). The optimized rice husk char was further characterized for elemental and proximate compositions, thermal behavior, specific surface area, as well as surface functional groups. Results from the analysis of variance (ANOVA) revealed that the quadratic model best fits each of the responses. Pyrolysis temperature had the greatest influence on each of the responses, followed by heating period, and lastly heating rate. Optimum pyrolysis conditions were found to be temperature (406 °C), heating rate (10 °C min−1), and heating period (60 min), resulting in char yield, fixed carbon, and ash contents of 35.26, 55.39, and 35.01% dry basis, respectively. Compared to raw rice husk, the resulting rice husk char was found more suited as activated carbon precursor, due to its enriched carbon content (60.35%) and specific surface area (123.9 m2 g−1). Thermogravimetric analysis of the rice husk char revealed that thermal activation temperatures higher than 400 °C may be required to considerably devolatilize the char, forming a more porous activated carbon.