

## Evaluation of secondary biomass feedstocks for densified bio-pellet production

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The global and national energy crisis is intensified by the environmental impacts and scarcity of conventional energy sources. This study assesses the suitability of locally available biomass residues, such as banana-peel, and corncob, for bio-pellet production, aiming to meet the country's energy demand and reduce reliance on imported fossil fuels. The main objective was to investigate the energy capacity and combustion performance of these non-woody feedstocks. Prior to pelletization, each type of biomass was sun-dried, oven-dried, ground and sieved to ensure the uniform particle size. The produced pellets were tested in terms of their physicochemical, combustion, and mechanical properties according to the requirements of ISO 17225-2 and 6. Neem wood pellets were used as the control group to compare the performance of non-woody pellets made from banana-peel, corncob and banana-peel: corncob blend (1:1 W/W). The results showed that, among the non-woody pellets, the banana-peel pellet was the most effective with the highest calorific value ( $17.85 \pm 0.25$  MJ/kg), favourable Specific Fuel Consumption (SFC) ( $196.00 \pm 1.5$  g/l) and lower burning-rate ( $0.92 \pm 0.02$  g/min). Further, a bluish flame was observed during combustion, which indicates a cleaner energy release. However, the lowest compressive strength ( $2538.87 \pm 282.03$  Pa) suggests handling limitations. Additionally, banana-peel + corncob blended pellets have a compressive strength ( $8322.66 \pm 1393.92$  Pa) better than either of the individual non-woody feedstocks with moderate calorific value ( $17.23 \pm 0.12$  MJ/kg), favourable SFC ( $194.6 \pm 2.95$  g/l) and burning-rate ( $1.33 \pm 0.04$  g/min). In contrast, corncob pellets showed lower compressive strength ( $6615.36 \pm 348.18$  Pa), lower calorific value ( $16.83 \pm 0.22$  MJ/kg), moderate SFC ( $264.20 \pm 3.2$  g/l) and higher burning rate ( $1.42 \pm 0.03$  g/min). In conclusion, the findings showed that banana-peel pellets demonstrated the most efficient non-woody feedstock, aligning with the ISO standard and comparable combustion characteristics to wood-pellets, making them promising candidates for clean, affordable, and sustainable bio-pellet applications.

**Keywords:** *Bio-pellets, Characterization, Densification, Non-woody biomass, Renewable energy*