# Indoor Emission Assessment of Sago Charcoal Pellets: Scientific Basis toward Sustainable Biomass Energy Policy and Co-Firing Application

Hafidawati[1,2]*, Voni Setiaries[3], Elvi Yenie[1], Iwan Kurniawan[3], Muhammad Reza[1], Rizky Fahmi[1]

[1] *Environmental Engineering Department, Engineering Faculty, Riau University, Pekanbaru, Indonesia*
[2] *Center for Peatland and Disaster Studies, Riau University, Pekanbaru, Indonesia*
[3] *Agricultural Engineering Department, Agriculture Faculty, Riau University, Pekanbaru, Indonesia*

## Abstract

Sago bark furnace charcoal, a by-product of sago starch industries, remains an underutilized biomass resource despite its high calorific value of 5,673.88 cal/g. This study evaluates indoor air pollution and aerosol emissions from the combustion of pellets made from this material using three natural binders—tapioca flour (BPTT), maize starch (BPTM), and sago flour (BPTS)—each at a 5% ratio. The pellets were characterized by proximate and calorific value analysis and were combusted using two stove types: a conventional biomass stove and a TLUD (Top-Lit UpDraft) gasification stove. Combustion emissions of CO and $NO_2$ were measured along with fuel consumption rates. Pellet with maize stars (BTPM) produced the highest quality fuel, meeting SNI 01-6235-2000 standards, with a calorific value of 7,278.43 cal/g and 75.71% fixed carbon. CO concentrations remained below indoor air quality limits, while $NO_2$ levels exceeded the standard, especially in TLUD stoves (1,150.1 $\mu g/m^3$). Fuel efficiency was higher in the TLUD stove (2.51 g/min) than in the conventional stove (2.68 g/min), indicating a trade-off between energy efficiency and pollutant generation. These results support the need for stove design improvements and emission mitigation strategies. Furthermore, the combustion and emission characteristics revealed in this study serve as scientific groundwork for evaluating the potential of sago charcoal pellets in co-firing applications with coal in power plants (PLTU), bridging local biomass innovations with sustainable energy policy and contributing to cleaner, health-conscious energy transitions.

***Keywords***: Sago charcoal; Biomass pellet; Emissions Indoor air quality; Clean energy policy.