

Energy Valorisation of Açaí Seed Biomass: Integrating Anaerobic Digestion and Thermochemical Processes in the Brazilian Amazon

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Abstract:

Açaí seed biomass, a widely discarded and non-degradable by-product of the Amazonian production chain, has emerged as a promising and sustainable alternative for bioenergy generation, with potential environmental, economic, and social benefits. This study presents an exploratory and applied approach to assess the potential of this material through two complementary energy recovery routes: anaerobic digestion, with possible co-digestion and pre-treatment adjustments, and thermochemical processes such as pyrolysis and gasification, aiming to enhance its energy and environmental viability.

The research began with an analysis of operational data from a pilot-scale biogas plant located in Macapá, Amapá, developed through a partnership between the State University of Amapá (UEAP) and the Amapá Rural Extension and Development Institute (RURAP). The system uses a 1,300-litre biodigester with a 700-litre gas tank and operates under continuous anaerobic digestion conditions, with a daily processing capacity of up to 18 kg of animal manure or 4 kg of organic waste.

During the tests, operational challenges were identified, particularly alkaline pH levels (≥ 8.8), ammonia accumulation, and dissolved oxygen (~ 2.9 ppm), all of which negatively affected microbiological stability. To mitigate these effects, activated carbon derived from açaí seeds was applied as a multifunctional additive—serving both as a bio-stimulant for methanogenic microbiota and as a gas-line filtering medium, improving combustion efficiency and contributing to overall process stability.

Additionally, the literature highlights the high potential of açaí biomass for thermochemical conversion, particularly pyrolysis for bio-oil production and gasification for syngas generation. These routes strengthen the energy value of the biomass and support its use in both rural and urban Amazonian contexts.

The methodology includes small-scale biodigester trials using a mix of organic waste enriched with 10% pre-ground açaí seed. The system is monitored for key operational parameters such as pH, temperature,