Aqueous enzymatic extraction as a green alternative to recover macauba (*Acrocomia aculeata*) kernel oil: A study based on the process efficiency using proteolytic enzymes

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Exploiting renewable and high yield feedstocks is essential for the sustainable development of industries across various sectors, including chemical, food, pharmaceutical, and agribusiness. In this context, macauba (*Acrocomia aculeata*) provides two distinct sources for oil, pulp and kernel, making it highly versatile for industrial applications. While previous studies have focused on oil extraction from macauba pulp, research on kernel oil extraction using AEE remains limited. This study assessed the aqueous enzymatic extraction (AEE) efficiency of the oil from macauba kernels. The extraction was conducted with (i) Protezyn® APP 3000 LP, (ii) Savinase 16 L, and (iii) Alcalase 2.5 L at 2% w/w or v/v, at solid/liquid ratio of 1:5, 55°C, 250 rpm, for 2 h. Water or 0.1 M phosphate buffer (pH 5) was used as solvent, while control assays were conducted without enzymes to evaluate the impact of enzymatic action on oil recovery. Process efficiency was calculated using Soxhlet extraction as a reference. The extractions performed with phosphate buffer achieved higher efficiencies - Alcalase (69.0 ± 0.09%), Savinase (67.8 ± 0.08%), and Protezyn (65.7 ± 0.73%), compared to those conducted with water, which yielded 58.0 ± 4.97%, 52.5 ± 1.03%, and 50.1 ± 3.17%, respectively. The control extractions, performed without enzymes, showed significantly lower efficiencies with water (13.07 ± 0.21%) and buffer (34.2 ± 8.18%). The improved extraction efficiency observed when using buffer solutions is due to their ability to maintain a stable optimum pH for enzymes, which, along with optimal temperature, enhances enzymatic hydrolysis and facilitates the oil release. However, the higher costs of buffer solutions may affect economic viability, requiring careful evaluation, particularly concerning wastewater treatment requirements. Moreover, the significantly lower recovery in control experiments underscores the essential role of protein hydrolysis in oil extraction. In conclusion, the aqueous enzymatic extraction (AEE) of macauba kernels offers an eco-friendly alternative to conventional methods, demonstrating good oil efficiency. Further studies are necessary to enhance process efficiency and assess its industrial applicability.

Keywords: Renewable Resources, Proteases, Vegetable oil, Proteases, Sustainability