# BREWERY'S SPENT GRAIN BIOREFINERY: A SUSTAINABLE APPROACH TO RECOVER VALUABLE MOLECULES AND PRODUCE GREEN ENERGY

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## ABSTRACT

Biorefineries offer an advantageous and sustainable solution for managing by-products from the agro-industry while enabling the recovery of valuable molecules and biogas production from residual biomass. This study applied this approach to the beer industry's main by-products: Brewery's Spent Grain (BSG). BSG is typically used as animal feed but shows potential for biorefinery applications due to its high protein content and favorable C/N ratio. By treating this biomass with an ionic liquid consisting of triethylamine and sulphuric acid, nanostructured lignin (LN) was extracted and recovered, while protein hydrolysates (PH) were obtained by applying a hydrolytic process conducted in an alkaline environment. LN and PH are valuable products with potential uses in various fields, such as plant biostimulants and, in the case of LN, even nanocarriers for targeted active compound delivery. Furthermore, the remaining biomass was used as a substrate for the Anaerobic Digestion (AD) to produce biogas. The AD process was carried out in lab-scale batch reactors under mesophilic conditions (37°C), using a digestate as inoculum and untreated BSG as the control. The results showed that BSG has a high potential for biogas production, with the AD process ending after 63 days. The extraction of LN and PH from BSG reduced the biogas production time, thus resulting in lower operating costs, but showed a lower biogas yield than untreated BSG. This suggests that co-digestion with other waste products might be a better approach to improve the amount of bioenergy obtainable from these matrices. Overall, this study highlights the potential of BSG to be reused in a circular economy framework, adding value to this by-product and improving its management.

**Keywords:** Biogas, Biorefinery, Green-chemistry, Waste, Agroindustry

## INTRODUCTION

The continuous global population increase intensifies energy demands, which non-renewable sources alone cannot satisfy. Fossil fuels, heavily relied upon, contribute to environmental issues, with carbon dioxide emissions from combustion processes being a primary cause of global warming [1]. Thus, there is a critical need to adopt renewable energy alternatives, and biogas has emerged as a promising clean energy source for both household and industrial use [2].

Biogas is produced through anaerobic digestion (AD), an environmentally friendly process where microorganisms break down organic matter without oxygen [2]. AD can