OPTIMIZING BIOGAS PRODUCTION FROM OLIVE OIL MILL RESIDUES: A COMPARATIVE EVALUATION OF TREATMENT TECHNIQUES FOR SUSTAINABLE RESOURCE RECOVERY

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ABSTRACT

The olive oil sector is one of the most widespread agricultural and agro-industrial activities in the Mediterranean region, and it also produces a significant amount of waste biomass. This research aimed to find energy valorisation for the olive oil by-products through biogas/biomethane production from olive pomace (OP) and olive mill wastewater (OW). To this end, these biomasses underwent preliminary treatments: the OP was processed using an ionic liquid (IL) consisting of triethylamine and sulfuric acid [Et_3N][HSO_4], which removed hemicellulose and lignin, thus allowing recovering of the insoluble OP, mainly composed of cellulose. On the other hand, OW was treated through freeze-drying. After that, the pulp from olive pomace (POP) and freeze-dried OW (FDOW) were subjected to anaerobic digestion in lab-scale reactors. The biogas output from these materials was compared to the biogas yield shown by the untreated biomasses (OW and OP). FDOW anaerobic digestion resulted in the highest amount of biogas production, likely due to surface and structural modifications caused by the freeze-drying treatment, which presumably enhanced microbial activity. In contrast, the IL treatment of POP significantly lowered the biogas production, which ended after two days of digestion, resulting in a minimal yield. Future research will focus on co-digesting POP and FDOW with a nitrogen-rich biomass, such as Brewery's Spent Grain, to potentially increase biogas output and better understand the cause of the low yield.

Keywords: Biogas, Biorefinery, Food industry, Recovery, Waste

INTRODUCTION

Currently, the overall area of olive production reaches 11.5 Mha with a 97% of worldwide olive-oil production centred in the Mediterranean area [1]. Olive oil is usually mechanically extracted from olives, producing two main by-products: olive mill wastewater (OW) (38 – 48%) and olive pomace (OP) (35 – 45%).

OW has an acidic pH (4.2 - 5.9), high content of water, high level of phenolic compounds (0.5 to 25 g L−1), and other organic substances (14 – 15%), such as lignin and cellulose. Improper disposal of OW has an adverse effect on the environment, like soil deterioration, hydrophobicity, and phytotoxic impact on plants [2].

The OP has a pH of 4.8 – 5.2 and a high concentration of phenolic compounds (200–300 mg/100 g), making it an environmental hazard [3]. Despite this, these wastes are