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# BIOETHANOL FROM FOOD WASTE – A COMPARATIVE STUDY OF AN ACIDIC AND AN ENZYMATIC PATHWAYS

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## 1. INTRODUCTION

A fraction of the organic matter present in municipal solid waste (MSW) is food waste (FW), which can vary from 26 to 66% of the MSW volume (IPCC, 2019). According to the United Nations (UN), 1.3 billion tons of food are wasted or lost per year worldwide (GUSTAVSSON, 2011). If it were a country, FW would be the world's 3rd largest emitter of greenhouse gases (FLANAGAN; PRIYADARSHINI, 2021). This residue is rich in carbohydrates, proteins, and lipids, therefore, a potential substrate for bioprocesses. Thus, this study aims to evaluate two routes of hydrolysis of food residues - one acidic and the other enzymatic - to obtain reducing sugars for ethanol fermentation with *Saccharomyces cerevisiae*.

## 2. METHODOLOGY

The FW was collected from the company Lógica Ambiental, in Recife, PE. The material came from cafeterias and was composed of beans, rice, pasta, puree, coffee grounds, meat, fish, fruit, and vegetable peels. The biomass was ground in an industrial crusher, dried in a forced circulation oven at 65°C, and crushed in a Willey mill. The FW was characterized for the contents of glucan (cellulose and starch), hemicellulose, lignin and ash, proteins, and lipids.

Acid hydrolysis was evaluated via a full $2^3$ factorial experimental design with triplicate at the center point. The concentration of sulfuric acid (0.5% - 1.5% v/v), solids load (5% - 15% m/v) and reaction time (20 min - 40 min) were evaluated in a bench autoclave at 127 °C. The response variable was the concentration of reducing sugars (RS). The best test was performed with the degreased material.

Enzymatic hydrolysis was performed on a shaker table at 150 rpm, using α-amylase and amyloglucosidase in a 50 U/g of biomass ratio, with 10% (m/v) solids loading, pH 6.0, at 55°C, for 48 h. The tests were carried out with the untreated and degreased material, and the levels of RS were evaluated.

The hydrolyzed media – acidic and enzymatic, with and without lipid extraction – were fermented with *S. cerevisiae*, with 10% (m/v) of cells, for 24 h at room temperature (~25 °C ), without agitation. Fermentability was evaluated by bioethanol concentration.

The RS concentration was determined by the 3,5-dinitrosalicylic acid method. Lipid extraction was performed with n-hexane in Soxhlet, and bioethanol concentration was evaluated in High-Performance Liquid Chromatography.

## 3. RESULTS AND DISCUSSIONS

The chemical composition of the FW was 66.26 ± 8.10% glucan (cellulose and starch); 2.9 ± 0.31% lignin; 11.78 ± 0.24% lipids; 22.85 ± 1.97% protein; 8.63 ± 0.80% ash and 10.74 ± 0.45% extractives. No hemicellulose was detected. The best condition for acid hydrolysis was 1.5% v/v $H_2SO_4$; 15 % (m/v) solids concentration, in which 78.69 ± 8.36 g/L of SR were obtained, which represents an efficiency of 76.26%. This efficiency was higher than that obtained in the enzymatic process of 45.32%. At the 95% confidence interval, there was no significant difference between the processes with untreated and degreased material in both hydrolyses.

Bioethanol production for the acid hydrolyzed media was 24.15 ± 0.56 g/L and 4.48 ± 0.00 g/L for the untreated and degreased material, respectively. For the enzymatic media, the bioethanol production was 21.94 ± 0.50 g/L and 20.53 ± 1.75 g/L for the untreated and degreased material, respectively. It is observed that, for the enzymatic hydrolyzed media, there was no difference between the untreated and degreased material. However, for acidic media, the presence of lipids favored fermentation.

## 4. CONCLUSION

The study reveals the potential of food waste for ethanol production which has a large generation globally. It was observed that the acidic route produces more simple carbohydrates than the enzymatic route in less time. In addition, bioethanol production was higher for the acidic medium without biomass treatment. Therefore, it is concluded that this route has potential for FW bioprocesses and should be better studied.

## 5. REFERENCES

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