Maestría en Ingeniería en Diseño de Bioprocesos

Biorefinery of the waste obtained in the coffee threshing process

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1. Introduction

Coffee is one of the main agricultural products, with an important weight in world trade, generating annual income to exporting countries [1]. Until 2015, Mexico ranked ninth as a global coffee exporter with a production of 664,963 hectares, of which 89.7 percent was concentrated in five entities: Chiapas (36.0%), Veracruz (19.7%), Oaxaca (17.8) %), Puebla (9.3%) and Guerrero (6.8%) [2].

In recent years the coffee industry has shown a significant increase, because coffee has become the most consumed beverage by millions of people worldwide; consequently, it becomes an activity with problems due to the inevitable generation of waste and generated byproducts, the integral use of them with specific applications promises a sustainable development of the industrial economy and of the producer country [3].

2. Objectives

2.1. General objective

Establish a biorefinery for the use of waste from the coffee threshing process

2.2. Particular objectives

- Characterize the coffee residue by proximal and physico-chemical analysis.
- Evaluate the use of coffee residues to obtain bioethanol and hydrolytic enzymes through crops.
- Elaborate and characterize the products obtained from coffee residues.

3. Methodology

The coffee residues were collected in the municipality of Ahuacatlán, located in the Sierra Norte of the State of Puebla. Figure 1 shows the methodology.

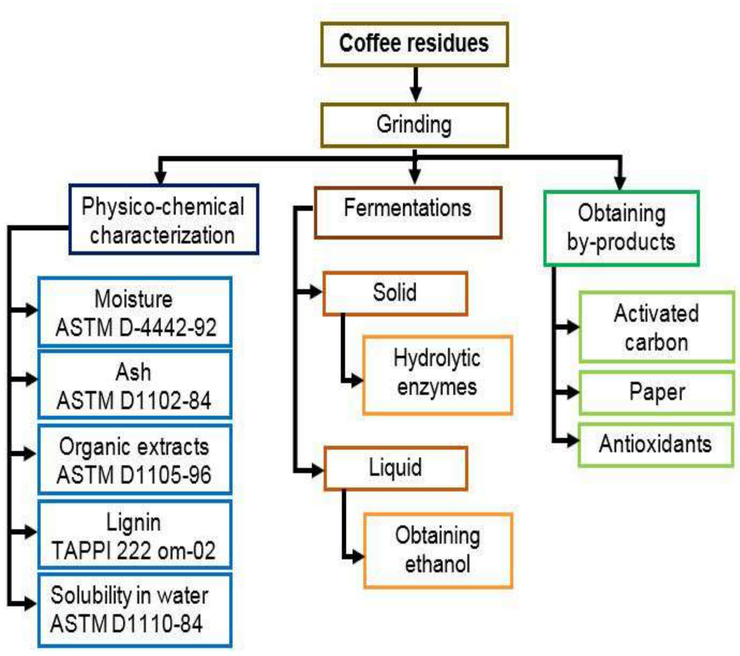

Figure 1. Methodology of treatment of coffee waste

Figure 2. Waste grinding

To obtain reducing sugars, an experimental design 2^3 was proposed.

Obtain reducing sugars

Table 1. Independent variables in the factorial design 2^3 where T is the Temperature (°C), H_2SO_4 is the concentration in %, t is the time (hours).

Treatment	T (°C)	H_2SO_4 %	t (hrs)
1	-(70)	-(3)	-(1.5)
2	+(110)	-(3)	-(1.5)
3	-(70)	+(7)	-(1.5)
4	+(110)	+(7)	-(1.5)
5	-(70)	-(3)	+(2.5)
6	+(110)	-(3)	+(2.5)
7	-(70)	+(7)	+(2.5)
8	+(110)	+(7)	+(2.5)

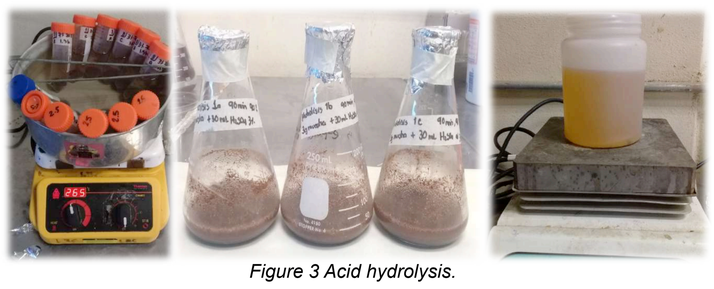

Figure 3 Acid hydrolysis.

Figure 4 Methods of determination of total sugars and reducers.

Fermentation

Figure 5. Bioreactor scale fermentation.

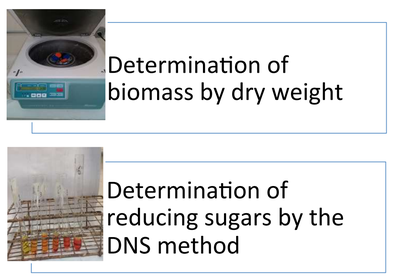

Figure 6. Determinations of biomass and substrate.

Paper

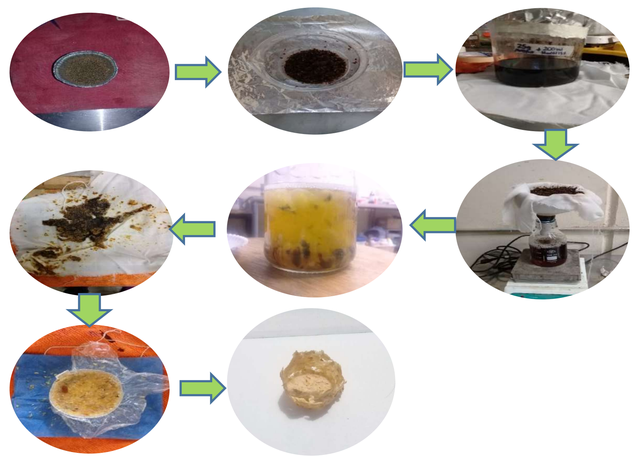

Figure 7. Papermaking process.

Activated carbon

Figure 8. Activated carbon manufacturing process.

4. Results

Table 2 shows the physico-chemical characterization of coffee residues.

Table 2. Physicochemical characterization of coffee residues.

Component	Variable
Humidity (%)	17
Dry material (%)	83
Ashes (%)	6.2
Organic extracts (%)	3.8
Soluble extracts in cold water (%)	18.86
Soluble extracts in hot water (%)	13.54
Lignin (%)	40
pH	6.8

Figure 9 shows the main results obtained of hydrolyzate.

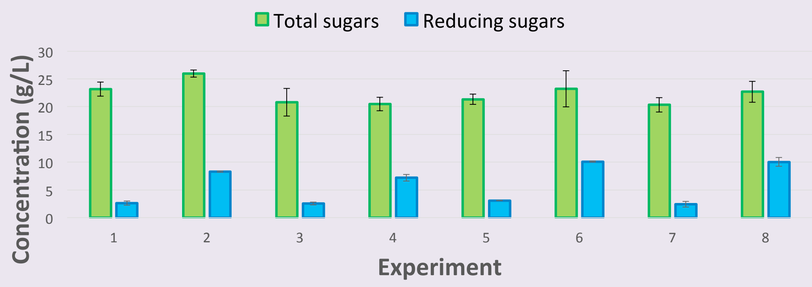

Figure 9 Concentration of reducing sugars according to the treatments proposed in the experimental design.

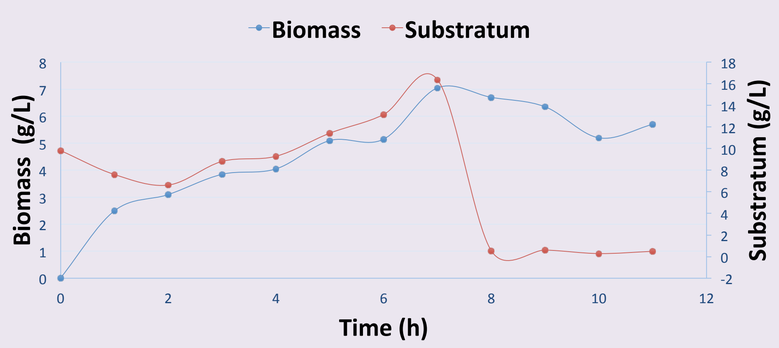

figure 10 Growth kinetics and substrate behavior in fermentation in formulated medium.

Figure 11 Paper.

Figure 12 Activated carbon.

5. Conclusion

-The coffee residue was characterized. In the production of total sugars, the use of other equipment is being tested to corroborate the results obtained. Once this is done, the hydrolysis selected for alcoholic fermentation is carried out in a greater quantity. In the elaboration of paper they are trying more variants for the obtaining of bio-pots. For activated carbon, product evaluations are being carried out. In the obtaining of hydrolytic enzymes is working with the microorganism *A. oryzae* for its later use in solid fermentation.

Acknowledgements

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