Maestría en Ingeniería en Diseño de Bioprocesos

Title

Biorefinery for the full use of tabasco banana waste

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1. Introduction

The use of biotechnological processes for the production of goods and services has become a great alternative that offers solutions to problems arising from the application of traditional technologies.

Such products may even replace those of petrochemical origin, such as bioplastics and bioethanol, in addition to significantly reduce the damage to the environment.

In this paper the use of banana is proposed as biomass for obtaining different products taking advantage of its polymers content (starch, pectin) in the fruit as well as high carbohydrate content suitable for fermentative processes.

2. Objectives

2.1. General objective

Developing a biorefinery to use waste pulp and banana peel for products such as bioethanol, bioplastic, pectin and starch.

2.2. Particular objectives

- To characterize the banana peel and pulp by applying proximate analysis.
- To manufacture and to characterize bioplastic using banana peel.
- Producing bioethanol by fermentation with *Saccharomyces cerevisiae* and *Zymomonas mobilis*.
- Obtaing pectin and starch using pulp and peel of banana, respectively.

3. Method

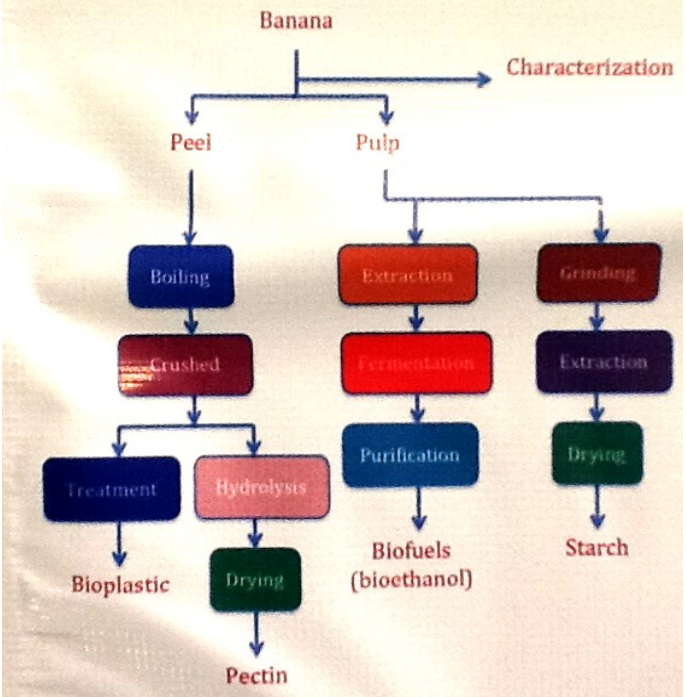

Figure1. Biorefinery of the banana waste. Unit operations are marked by colored blocks.

3.1. Proximate analysis

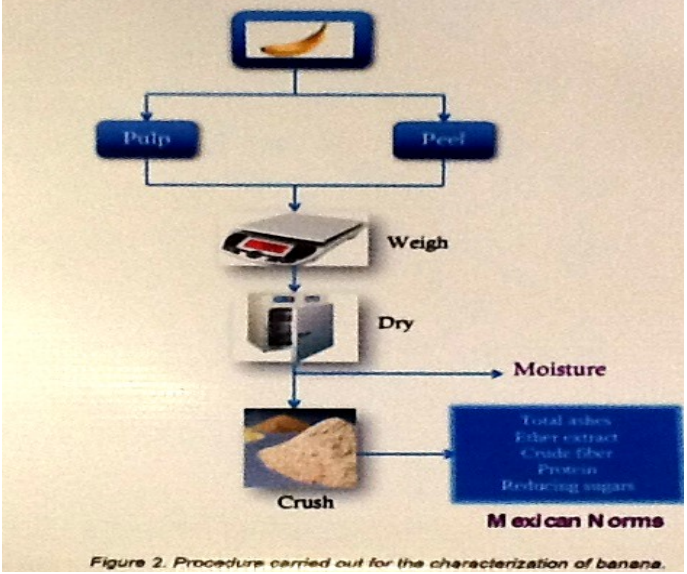

Figure 2. Procedure carried out for the characterization of banana.

3.2 Methodology of bioplastic

1. • Solution 1% of $Na_2S_2O_5$.
2. • The peels were dipped in this solution and boiled for 30 minutes.
3. • The boiled water was removed and the peels were dried.
4. • By a mortar peels were ground until a paste consistency.
5. • Add hydrochloric acid, glicerol and sodium hydroxide.
6. • The mixture is spread in a petri dish and dried.

Figure 3. Method for the obtaining of bioplastic.

3.3 Fermentation

- Extraction of sugars.
- Pre-inoculum.
- Free cells/cell immobilization.
- Preparation of culture medium.
- Batch fermentation.
- Analysis of samples.

Figure 4.Batch fermentations. Left with free cells and to the right with immobilized

4. Results

4.1 Banana characterization

Table 1. Proximate Analysis of pulp and peel of banana waste.

Component	Pulp (%)	Peel (%)
Moisture	78.5	89.13
Total ash	8.95	14.58
Ether extract	3.3	0.33
Crude Fiber	1.83	10.02
Protein	0.6	0.53
Reducing sugars	22.41	7.11
Total carbohydrates	62.91	67.43

4.2 Obtaining bioplastic

Film	Amount of peel (g)	Volume glicerol (ml)	Mass (g)	Thickness (cm)
1	25	2	6.71	0.1
2	25	3	6.85	0.1
3	25	4	7.05	0.1
4	30	2	8.11	0.12
5	30	3	8.23	0.12
6	30	4	8.31	0.12
7	35	2	9.41	0.15
8	35	3	9.52	0.15
9	35	4	9.66	0.15

Figure 5. Plastic obtained using banana peel. On the left using yellow shells unpigmented and right with more mature shells.

4.3 Batch fermentation

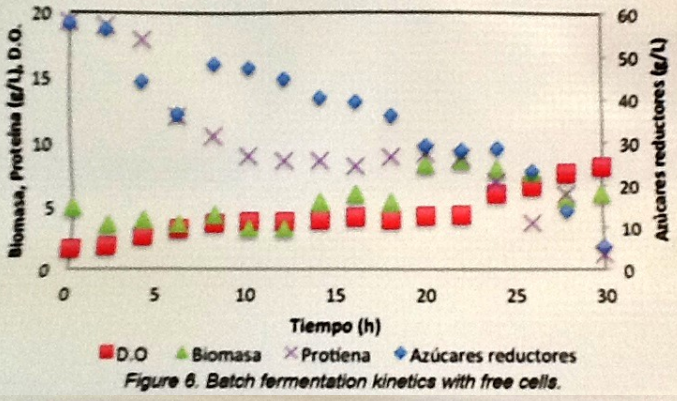

Figure 6. Batch fermentation kinetics with free cells.

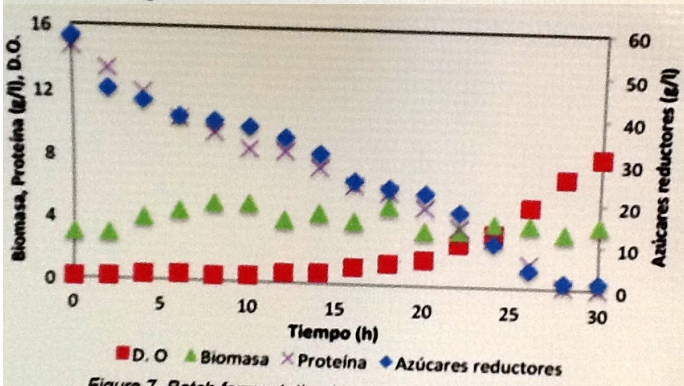

Figure 7. Batch fermentation kinetics with immobilized cells.

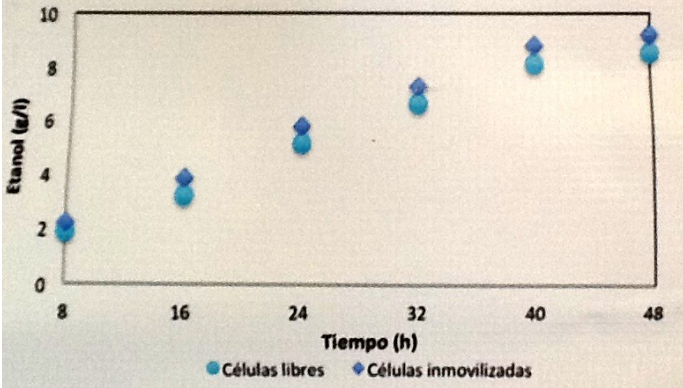

Figure 8. Comparison of ethanol production with free and immobilized cells.

5. Conclusion

The use of banana as biomass has many applications that can be exploited. Obtaining bioplastic was successful and it was observed that enzymatic browning in the peels had negative effects on the finish of the resulting material. The banana pulp has a carbohydrate content representing more than 60% of this meriting study it as a carbon source and is potential source for ethanol production were achieved as to obtain 8.55 g/l and 9.21 g/l using free and immobilized cells, respectively. It is demonstrating that cell immobilization increased the ethanol production.

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