Production of Bioethanol from a Local Natural Resource

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ABSTRACT

In this work, we have studied the possibility of energy recovery from the fruit wastes of Adrar University as a substrate for the production of bioethanol by anaerobic bioconversion in the presence of the yeast *Saccharomyces cervisiae*. During this study, we have prepared a black must in which a mass of 100g of the substrate used is placed in 1 L of tap water, after fermentation at 30°C for 72 h, the solution is filtered, then centrifuged and then a fractional distillation operation was carried out in order to purify the ethanol produced and we recovered a volume of 35 ml of the bioethanol. Finally, we applied an inflammation test on the bioethanol obtained which gives a positive result. The result shows that waste from the local natural resource has great potential for the production of ethanol.

I. Introduction

The growing demand for oil and the harmful effects such as climate change that result from it, have led to the search for alternative energy sources with very little impact on environement [1, 2]. Bioenergy, including bioethanol, biogas and biodiesel is feasible and have economically become the future solution of energetic and ecologic issues [3]. Among the different renewable energy sources used today, is that of biomass, which is in the form of solid or liquid products that can replace fossil fuels [4].

Bioethanol has long established itself as the leading biofuel in the world and the bioethanol market has continued to expand rapidly in recent years [5]. Ethanol is fermented from sugars, starches and cellulosic materials. Production of ethanol by fermentation from renewable carbohydrate materials has been attracting worldwide interst [6]. The current technology in industry is able to convert carbohydrates from dedicated crops such as corn, wheat, sorghum, potato, sugarcane, sugar beet and date palm fruit waste [7, 8].

The aim of this study is to evaluate the use of low-cost material obtained from local natural resource in Adrar University to extract reducing sugars and convert this latter to bioethanol.

II. Research Method

II.1. Substrate

The substrate used in this study was collected from Adrar University, harvested in November-december 2019 and sorted by degree of maturity. The substrate was stored in plastic bottles at 4 °C.

II.2. Analytical Methods

Some physic-chemical properties of the used substrate were determined such as: pH, dry matter content (DM), ash content and organic matter content. The pH is measured directly using a pH-meter (HANNA HI 3220). Measurement of drymatter (DM) should be determined as quickly aspossible, to limit losses by evaporation. TheAFNOR standard method NF U 44-171 consistsof a sampling of a maximum amount of sample, preferably a mass of 10 ± 0.1 g, by placing inan oven at 105 ± 2 °C for 24 h until a constant weight is obtained [3]. The pH isadjusted by adding sulfuric acid (H_2SO_4, 0.1N) and sodium hydroxide (NaOH, 0.1N).

II.3. Experimental Procedure

Commercial baker's yeast Saccharomyces cerevisiae was used forinoculation. Synthetic medium, which consisting 1 g of yeast is added to 100 ml of distilled water containing 12 g of sugar, with stirring for 60 min at 30 °C. For substrate juice preparation, two methods are applied, the 1stmethod consists in separating the substrate cores using a mixer to obtain a must rich in substrate pulp and the 2nd method used by M.A. Mazmanci [6] consists in extracting the maximum of reducing sugars substrate without pitting. For both methods, 200 g of substrate was placed in 1 L of tap water. After applying the two methods, a final concentration of 100 g/l (pulp/water) was used for the production of bioethanol. The obtained juice of substrate is shown at figure 1.

Figure 1. Juice of used substrate.

For bioethanol production, 100 ml of inoculum are added for each obtained must. Concentrated sulfuric acid 96% (commercial solution) is added to reduce the pH from 6.23 to the favorable yeast level (4.3- 4.8). Once the desired pH is reached, they are transferred to 1L fermentors and anaerobically conducted for 72 hours at a temperature of 30 ± 2 °C. After alcoholic fermentation, the substrate juices are separated by centrifugation. Afterthat, the ethanol contained in the must is distilled at the temperature of 78.5 °C [3]. The device of the bioethanol production is presented in the figure 2.

Figure 2. (a) Fermentation device, (b) distillation system.

III. Results and Discussion

Some physic-chemical properties of used substrate are listedin table 1.

Table 1. The Some properties of used substrate.

Properties	Value
pH	6.23
Humidity (%)	12.79
Ash content (%)	10.61
Organic matter (%)	89.39

The microorganism S. cerevisiae has an optionalanaerobic breathing on the alcoholic bioconversionprocess. In anaerobic phase, the glucose is transformed into the ethanol by fermentation effect [3]. The theoretical sucrosetransformation in the alcohol described using thefollowing chemical synthesis equation:

$$C_6H_{12}O_6 \xrightarrow{\text{S.Cerevisiae}} 2C_2H_5OH + 2CO_2 + Energy \quad (1)$$

The results indicate that the first method (our proposed method) gives best bioethanolif compred with the second method used by M.A. Mazmanci [6]. The comparaison between the two methods is shown in table 2.

Table 2. Comparaison between two methods for extracting of reducing sugar.

	First method (our method)	Second method [6]
Used substrate (g)	100	100
Inoculum volume (ml)	100	100
Volumeof filtrate (ml)	1000	700
Bioethanilvolume (ml)	35	11

Figure 3. Flammability test of produced bioethanol.

For the flammability testof the produced bioethanol, using a small quantity (30ml) of bioethanol in a crucible and lit it with a matchstick gave a blue fire. So the flammability test is positive according to this result (Figure 3).

IV. Conclusion

The aim of this study is the energy recovery from biomas valorization for biofuel production. The preliminary obtained results show that the best method recovered a volume of 35 ml of bioethanol afteranaerobic digestion at 30 °C for 72 h [9]. The results of this study show that the collected fruit wastes from Adrar University can be advantageously used as low-cost resource for bioethanol production.

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