Bioethanol Production of the lignocellulosics wastes in Algeria

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Abstract

Ethanol from renewable resources has been of interest in recent decades as an alternative fuel to the current fossil fuels.

Lignocellulosic biomass like wood and agricultural crops residues, are potential raw materials for producing several high-value products like fuel ethanol and biodiesel because they contains up to 80% from the polysaccharides.

Waste of corn and starch biomass is also the most abundant after waste in Algeria especially after harvest.

Our substrate of this research is the waste of maize, after corn harvest for consumption the waste of the crops composed of grains of corn and stalk are crushed and used for the alcoholic fermentation.

This is why a pretreatment is recommended. In order to accentuate the degradation of sugar the acid hydrolysis is very used. Acid hydrolysis is very important phase in the production of bioethanol. This is the purpose of our work in this paper.

Acid hydrolysis considerably increases bioethanol production as we have found a conversion rate of total sugar about 75% and an alcoholic degree found of second distillation of 38 °.

Keywords— waste, bioethanol, fermentation, acid hydrolysis.

Introduction

Ethanol or ethyl alcohol of chemical formula C2H5OH, it is a good fuel (High calorific value: 21700kJ / kg for ethanol against 35600kJ / kg for the isooctane) [1].

They are mixed with gasoline (5% ethanol in the biofuel marketed in Europe). Up to 20% of ethanol, conventional engines operate without problem, beyond an adaptation of these engines is necessary.

Biofuels are fuels derived directly from biological materials.

They have the advantage of reducing pollution and greenhouse gas emissions while diversifying the energy supply.

Ethanol and biodiesel are the two most common types of biofuels, or biofuels. In 2009, the United States, Brazil, and Germany accounted for three-quarters of global ethanol production and more than half of global biodiesel production. According to the International Food Policy Research Institute, biofuels could help increase rural incomes and significantly reduce carbon emissions [2].

The activity of our present society leads to a colossal consumption of fossil fuels, therefore these energy resources must be properly managed in order to secure a share of these riches for future generations.

Organic ethanol is designed to be used as a substitute for fossil energy sources (gas, gasoline and diesel).

This new source of energy could be produced from biomass, in our corn is considered to be the most abundant renewable material in nature [3].

Thus, starch biomass can be used as a substrate for microbial fermentation in bioalcohol and therefore could reduce our reliance on non-renewable energy oil. In addition, and with universal environmental awareness, bioethanol is not harmful to the environment since its combustion does not contribute to the greenhouse effect. This argument is based on the fact that the CO2 formed during the combustion of bioethanol is consumed by the rebirth of biomass in a very convenient time.

Knowing that the cost of production of bio-alcohol is higher than that of fossil fuels, a political decision must be taken to make bioethanol very competitive with other types of energy, especially fossil fuels [4].

The production of ethanol from maize is carried out according to the following stages: pretreatment and hydrolysis of starch into fermentable products, followed by fermentation and distillation to obtain bioethanol. This process of fermentation is shown in fig 1.

This biomass is rich in starch (in this case it is corn, starch is a polyglucan (glucose polymer) composed of amylose and amylopectin [5].

It is a reserve polymer accumulated in a transient form in chloroplasts. chlorophyllous tissues or in more durable form in reserve organs such as tubers or seeds.

It serves as a carbohydrate reserve for the plant and is used for various food and non-food uses [6].

The technological properties of starch differ according to the proportions of amylose and amylopectin.

The yeast used is the so-called "beer yeast" (Saccharomyces cerevisiae) [7], is a generally unicellular eukaryotic protist belonging to the fungal kingdom (fungi). It is an egg-shaped cell, similar to a very small egg with a size of 8 to 10 m or a micrometer [8].

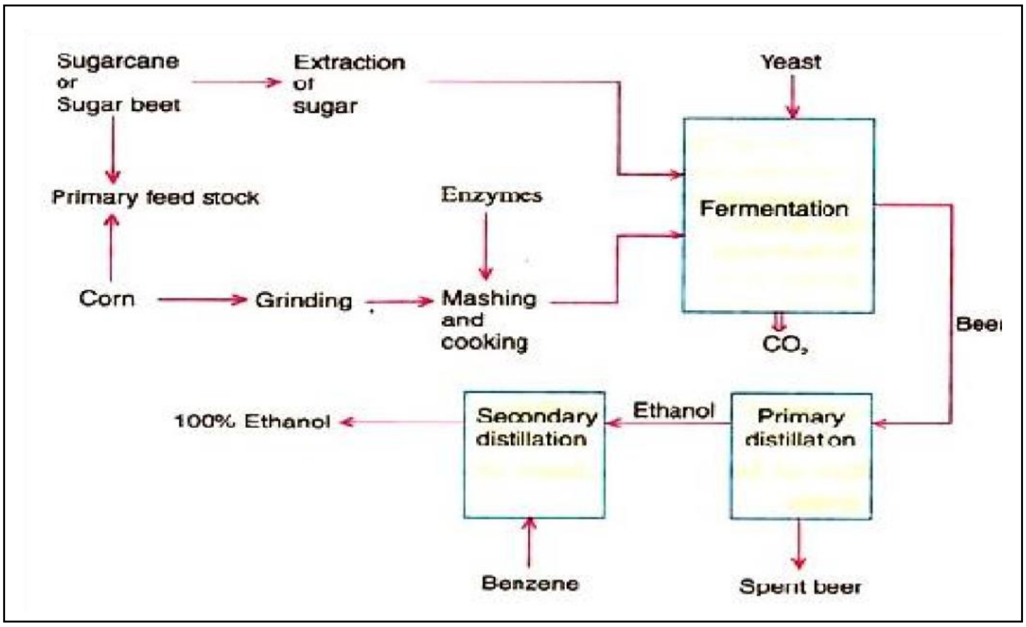

Fig. 1. Process of Ethanol Production [9]

Methods

The alcoholic fermentation of the maize drives through the following steps (see fig 2):

1. Grinding the grains of corn to produce flour,
2. Steaming the flour at 100 ° C for 2 hours,
3. Adding Acid hydrochloric (1N) in order to convert the polyglucan to simple sugar [10],
4. Adding yeast at the substrate,
5. Put the fermenter at the temperature 38 ° C (see figure 2),
6. Follow the fermentation for 72H,
7. Distillation of the ethanol,
8. Increasing the purity of the bioalcohol by a second distillation [11].

It should contain enough information to enable the reader to understand what was done. It should contain information regarding research design, sample and data collection, respondents profile, measurements of variables and data analysis method.

Fig.2. Experimental prototype of the alcoholic fermentation

ANALYSIS METHODS Dry matter

Duplicates of 0.5 g solid material or 10 ml of liquid sample were dried at 105 °C overnight to determine the dry weight. The samples were thereafter heated to 550 °C for 3 h to determine the ash content [12].

Analysis of carbohydrates in liquid fraction

In order to quantify the sugar content in the liquid fraction, a weak hydrolysis was performed at 121 °C for 10 min using 4% H_2SO_4, in duplicate [13]. The concentrations of sugar monomers were determined by HPLC, as described below.

HPLC analysis

The amounts of released sugar monomers in the hydrolysate as well as concentrations of ethanol, malic
acid, succinic acid, glycolic acid, formic acid and acetic acid were determined by
HPLC (Shimadzu) using a Rezex ROA column (Phenomenex) at 63 °C and 4mL
H_2SO_4 as eluent at a flow rate of 0.6 ml min 1. A refractive index detector (Shimadzu) was used [14].

Results

At the laboratory level, the fermentation was carried out with different maize doses in order to optimize the good operating conditions of the maize fermentation is shown in fig 3.

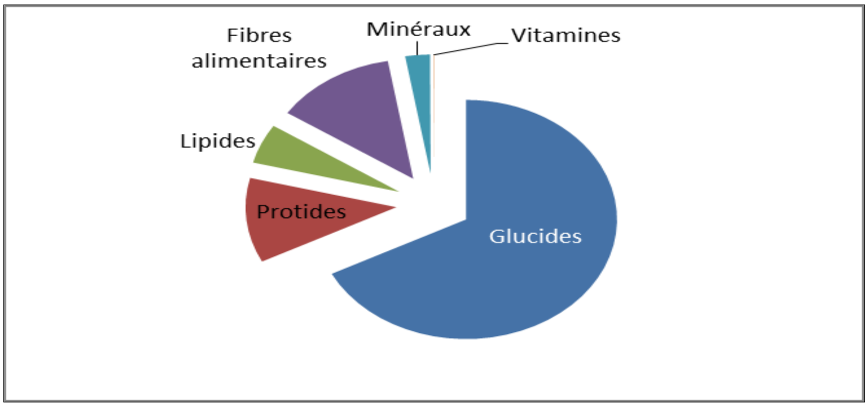

Fig.3. Composition of the Maize [15]

The fermentation is carried out anaerobic for 72 hours. During the fermentation we followed the following parameters: Acidity of the must, Temperature of the fermenter; the level of glucose n; Followed by the evolution of the color and odor of the must; after 72 hours of fermentation, the reaction is stopped. The table 1 shows the physicochemical characterization of the three fermentation tests. After fermentation we do the distillation of the must show in fig 4.

Fig 4. Distillation of the maize after fermentation

The dilute acid is chosen over concentrated acid for biomass pretreatment. Dilute acid pretreatment primarily hydrolyzes up to 100% of the hemicellulose into its component sugars

(e.g. xylose, arabinose and galactose), depending on the pretreatment conditions; the dilute acid pretreatment with mixture of acetic-chlorid acid was significantly enhanced 35, 84% production of ethanol [16]. Acid concentration of 5 mL/L of substrate can remove rate of starch compound to some extents and thereby enhanced the biodegradability of rice straw as represented by the increase of hydrolysis rate because it could supply more hydrogen ions which can help to solubilize the substrate.

The longer pretreatment time did not increase the removal of the starch, it can be concluding that dilute acid pretreatment not effective in dissolving lignin but effective for removing the complex compound [17].

In our study the fermentation of the maize we obtained a removal of sugar equal to 75%. This result encourages us to continue in this research, because from maize fermentation we found a renewable energy.

The degree of the alcohol after second distillation is 38° demonstrate in table 2, which is a very good result and we should do other experience in order to increase this degree.

TABLE I

YIELD OF SUGAR REMOVAL AFTER FERMENTATION OF THE MAIZE

T (°C)	pH	Dry matter (g/L)	Volume of HCL (mL)	Maize (g/L)	Removal Sugar Yield (%)
30	4,66	27,71	5	20	72%
30	4,36	24,09	5	40	69%
30	4,00	23,28	5	80	75%

TABLE III

DEGREE OF ALCOHOL OF THE WINE FORMED AFTER THE FIRST AND SECOND DISTILLATION

Degree of alcohol after the first distillation	22°
Degree of alcohol after the second distillation	38°

Ethanol can be stored indefinitely, as long as it is safe from air and water. Due to the hydrogen bonding properties of ethanol, great care must be taken to protect it from exposure to these elements as it can absorb the water contained in the air. If the ethanol used as a gasoline additive contains too much, the water will separate from the mixture and form a deposit in the fuel tank [18].

Conclusion

Ethanol can clearly be produced from the lignocellulosic raw materials evaluated in this study. Pretreatment rice straw is commonly employed to decrease the recalcitrance of lignocellulosic for increased ethanol yield [19]. Pretreatment can decrease crystallinity of cellulose, increase accessible surface area, and reduce lignin content, depending on the functioning mode of the pretreatment methods. Although, various pretreatment techniques have been studied [20].

In this study, the acid treatment of the maize can be promoted because this treatment favorite bioethanol production which is renewable products, and can replace 10% of the volume of gasoline [21].

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