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Production of Bioethanol from Reed *(Phragmitesaustralis)*

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Abstract

This study was conducted to investigate the ability of reed as a biomass source to produce bioethanol as a result from fermentation and evaluate the hydrolysis pretreatment efficiency based on the conversion of cellulosic material to mono saccharides. A compare were made between the concentration of obtained ethanol from reed with pretreatment and reed without pretreatment ,the results showed that the reed which were pretreated with dilute sulfuric acid(0.5%) at140◦C for 1 hour gave higher concentration in ethanol after fermentation than the without pretreatment reed.

Keywords: Bioethanol; Renewable energy.

1. Introduction

Reed (*Phragmitesaustralis*) can be found all over the world except in Antarctica, but its core distribution area is Europe, the Middle East and America [1]. Reed is a so-called "second generation" biofuel. This term is used for biofuels that are produced from non-food biomass (e.g. reed) or agricultural residues, in contrast to the "first generation" fuels, which were derived from food crops (e.g. maize). Reed is a wetland plant genus which belongs to the family (*Poaceae*) and it has been utilized by man since ancient times. It is a tall, thin, highly productive grass with an above-ground biomass of up to 30 t ha-1 y-1. Due to its world-wide dominance, it is often cheap and readily available as a raw material [2].

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reed can be used as an energy source in three ways namely by combustion, biogas and biofuel production, all stems and leaves can be used regardless of length and diameter [3]. There has been a large amount of research work done on the digestion of cellulose into glucose, The generated glucose can be used to produce single cell protein as food for livestock or even for humans. Glucose can also be used as the starting raw material in the production of a wide variety of chemicals and biofuels [4]. People have been used reed for thousands of years. Some applications such as the manufacture of schnapps, coffee and boats are less popular today than they have been in the past [5]. Reed has several attractive characteristics for a dedicated biomass crop. The potential productivity of giant reed is from 29 t/ha/year to 46 t/ha/year, depending on the climate, geographical location, soil, and growing period [6]. It is also considered to be one of the most cost-effective energy crops, because it is perennial and its annual inputs, after establishment, are low, only harvesting cost depending on site and climate, irrigation and/or fertilization cost would be incurred on an ongoing basis reed has a low nutrient demand and can grow without pesticides on saline land using low quality, saline wastewater [7]. Finally, another significant advantage of reed is its good storability compared to many other biomass crops. It can be stored without any shelter protection, with only minor losses. These losses occur mainly in the leaf fraction, about 10%-15% of the total biomass production [8].The advantages of produce bioethanol that it can used at many fields like industry and using it to reduce the greenhouse gases by mixing it with gasoline in different ratios.

2. Materials and methods

Fresh reed was harvested (whole plant without roots) from the Tigris river riparian in Baghdad at Al-Qadiysia district, the harvested plant were washed with distilled water to remove the suspended particles then scatter on piece of plastic, dried on sun light for 5 days then it was transported to the laboratory where the experiments were done in two ways:

a. Without pretreatment reed

The dried reed was milled using blender and sieved to fine particles (80-100 mesh). After that 200 g of milled reed were stored in -20ºC till used.

b. Pretreatment reed (acid hydrolysis)

Two hundred grams of milled reed was pretreated with dilute sulfuric acid (0.5%) at 140 ºC for 1 hour [9]. The pH was 3.5 then it was washed with deionized water and NaOH were added to equilibrium the pH until it reached 5.

The fibers and saccharides were determine before pretreatment and after treatment also before and after fermentation.The yeast *Saccharomyces cerevisiae* was purchased from Baghdad local market. Before using it for fermentation, the yeast was activated. About 1 g of dry yeast was added to 20 mL of 5% sterilized glucose solution, activated at 38 ºC for 1h, cooled from 38 ºC to 30 ºC, and then used in the experiment. The yeast concentration was approximately108 cells/mL [10].

After that activated yeast (3 g) were added to reed (with pretreatment and without pretreatment reed) in sterilized circumstances in order to prevent any contamination [10]. One liter of distilled water was added to each mixture, then autoclaved in 121 ºC for 20 min. and left for fermentation 7 days later. It was kept in glass tank with pH 4.8 and air outlet to let the carbon dioxide formed to escape, The mixture was left for 7 days in incubator at 30 ºC. During that the ethanol concentration was determined every 2 days by using gas chromatography.

3. Results

Fibers and saccharides in reed were determined before and after fermentation. The following table shows the amount of fibers and saccharides estimated by percentage.

Table 1. The amount of fibers and saccharides estimated by percentage for reed samples

Samples	Total saccharides %	Total fibers%
Raw material	4.2	46
Fermented raw material	1.6	42.3
Hydrolysis raw material	9.5	37
Hydrolysis fermented raw material	3.2	26

The subsequent graph shows the concentration of ethanol in gram/liter from fermented reed including the two processes (without treatment and with treatment).

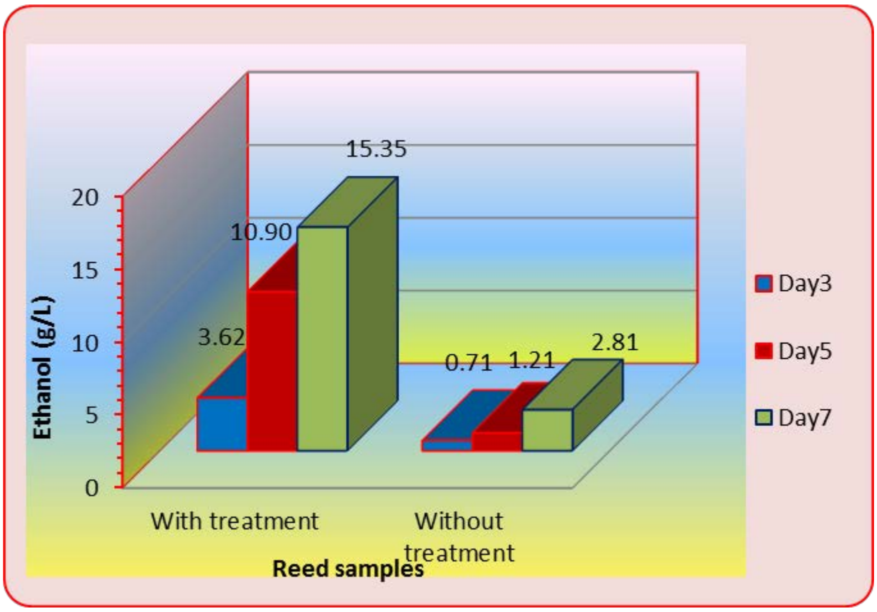

Fig. 1.The mean concentration of ethanol from reed in pretreated and without pretreatment samples after 3, 5 and 7 days of fermentation

The means of ethanol concentration values produced from reed samples with pretreatment were 3.62 g/L, 10.90 g/L and 15.35 g/L after 3,5 and 7 days respectively, while it was 0.71 g/L, 1.21 g/L and 2.81 g/L respectively for the same days after fermentation for the samples without pretreatment (figure1).

The figures (2)& (3) showed the ethanol concentration obtained from the reed samples by using GC technology.

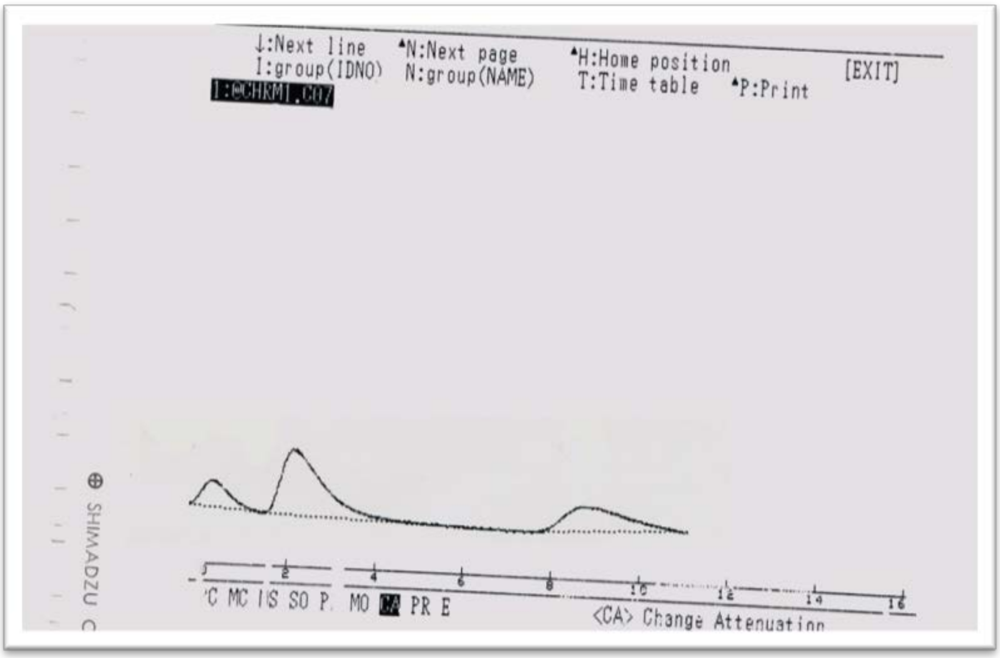

Figure. 2. Ethanol peak for without pretreatment samples of reed using GC technology

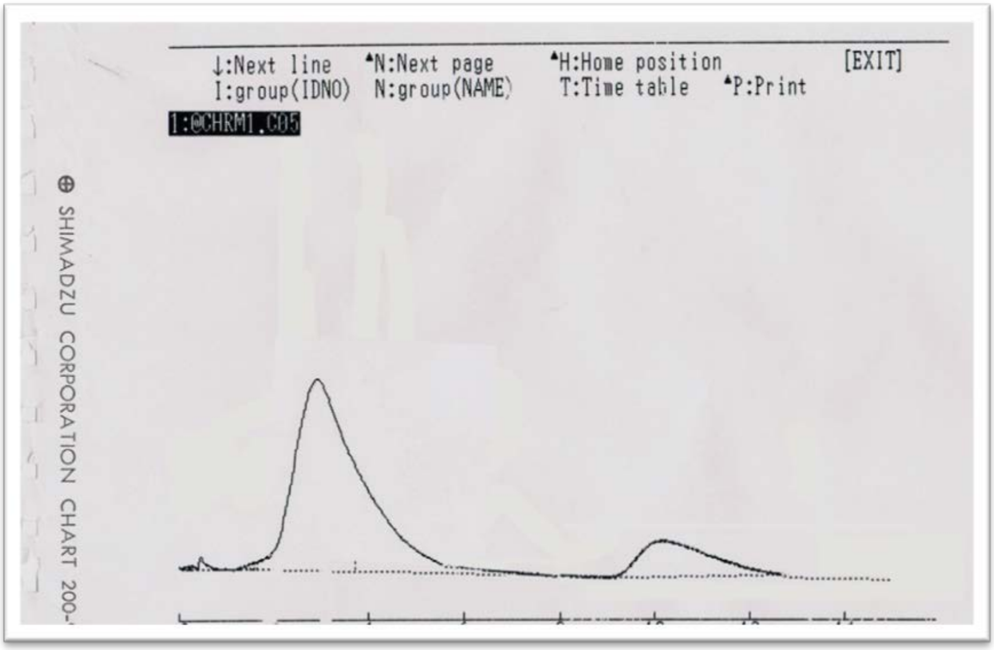

Figure. 3. Ethanol peak for pretreatment samples of reed using GC technology

4. Discussion

From the results illustrated in table (1) a drop of saccharides took place in raw reed after the fermentation has happen at 30°C because of the yeast activity and their ability to convert saccharides into ethanol. Also a minor drop of fibers was observed due to yeast activity to break down fibers.

Also the previous table shows an increasing in saccharides percentage vice versa decreasing in fibers percentage after hydrolysis (adding acid) due to the capability of diluted acid to degrade fibers into saccharides as the diagram showed in figure (1). Saccharides were consumed by yeast and converted into ethanol. The obtained results correspond with what [9] mentioned of breaking fibers into saccharides using diluted acid at specific heat.

These results showed that there was no full consumption for saccharides from the yeast, the reasons of this was the concentration of the ethanol which play an essential role at inhibition the metabolic processes which effect on consumption of saccharides [11].

The former figure illustrated that the highest value of production was 15.35 g/L for samples pretreated with dilute sulfuric acid (0.5%) and fermented for 7 days, while the lowest production was 0.71g/L for samples which were not treated and fermented for 3 days. The statistical analysis among the days of production (for pretreated samples) showed a significant difference ($P \leq 0.05$).

A statistical comparison was made between the days of pretreated and without treated samples this comparisons showed that there was a significant difference ($p \leq 0.05$) between them.

A rise in ethanol amount during the days of fermentation for both processes (without pretreatment and with pretreatment samples) was observed, this rise can be returned to the contact time between substrate and yeast.

Through the previous figure there was a great different between the ethanol concentrations of pretreatment samples and the samples without pretreatment, in which the ethanol concentration from pretreatment samples was more than the samples without pretreatment, that different in production due to the amount of saccharides in pretreatment samples which were more than the amount of saccharides in samples without pretreatment where the yeast consume the saccharides and convert it to ethanol and the different between saccharides and fibers before and after of fermentation and before and after hydrolysis can be seen in table (1).

5. Conclusion

From the obtained result we can conclude that reed have the ability to produce bioethanol by fermentation and the pretreatment with dilute sulfuric acid (0.5%) rise the production of bioethanol due to converting the fibers into saccharides .

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