International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol. 3, No.3, pp 1446-1449, July-Sept 2011

Fuel ethanol production from biomass conversion in Iran

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Abstract: Bamboo is a fast growing woody grass which is abundon in ponds of enzali port &Majnun Island in the North and South of Iran respectively that has great potential to be used as fuel ethanol production. It contains about 40% cellulose and 27% hemicelluloses respectively. In this investigation,bamboo was pretreated with dilute sulfuric acid prior to enzymatic hydrolysis process. The amount of dry feedstock solid liquid looking at 10% w/w was pretreated in an autoclave at different temperature (140ºC) with different residence times (30,90min.) and different sulfuric acid concentration (0.6, 1.2% w/w). Results showed that maximum glucose and xylose yields were achieved at 140ºC, 1.2% sulfuric acid concentration and 90min. After followed by enzymatic saccharification with cellulose and Β-glucosidase at the same pretreatment condition the yields of total reducing sugars were lose.
Keywords: Fuel ethanol, conversion rate, Hydrolysis, Biomass.

Introduction

Biomass is one of the most importants raw materials in bio-ethanol production[1]. plants contain sugar or starch that can be easily converted into sugars can be fermented to ethanol. Nonetheless, competition between biomass supply for fuel or for food application has been intensified in the recent years. This concern has led to growing interests is alternative, non- edible biomass resources. Lignocellulosic biomass such as wood, straw and grasses are viewed as potentially important sources[2].

The cellulose and hemicellulose content of biomass material can be hydrolyzed chemically or enzymatically. Processing of lignocellulosic to bioethanol contain of four steps: 1) Pretreatment, 2) hydrolysis, 3) ermentation and 4) distillation.

Pretreatments are performed to improve the digestibility of the lignocellulosic materials[3]. A pretreatment step opens up the biomass to enzymes that breakdown the hemicellulose and cellulose of the material into sugars that are formed into ethanol for recovery. It is crucial to improve the release of sugar both from hemicelluloses and cellulose fraction, and at the some time, avoid both the carbohydrate degradation and product that may inhibit hydrolysis and fermentation. Among all the pretreatment methods, dilute acid pretreatment is one of the most widely adopted method[4]. Significant efforts have been paid to various agricultural wastes[5,6,7,8]. Less research was focused on grasses, and even less on bamboo[9], Figure 1.

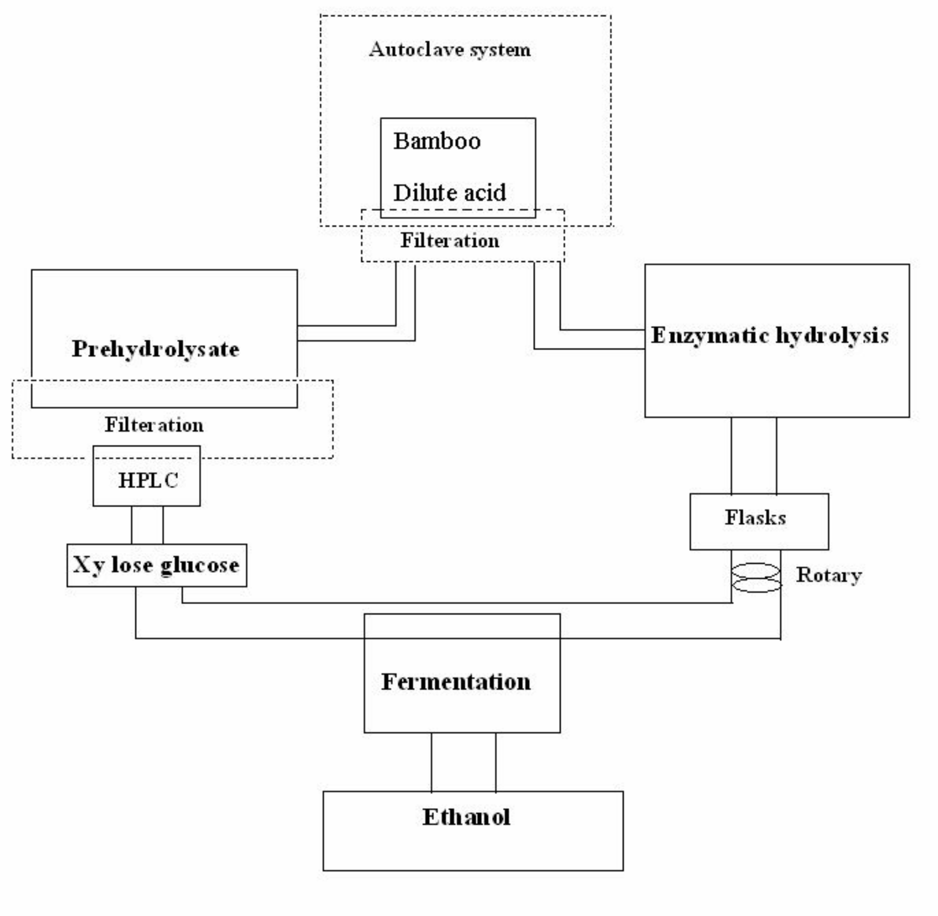

Fig. I .Schime diagram of ethanol production.

Experimental method

Bamboo was collected from ponds and smashed into particle size about 4mm, and then it dried. All of the materials were stored at room temperature in plastic bags. Bamboo sample of 5gr. on a dry basis was used each time. The amount of dry feed stock solid/liquid loading of 10% w/w was presented at temperature [140ºC] with different residence time (30, 90min) and different sulfuric acid concentrations (0.6 , 1.2 % w/w). Solid and liquid fraction were separated by filtration. The pretreated solid residues were washed with deionized water until the PH of the washed water was greater than 5. Figure shows conversion process of liqnocellosic material to bioethanol. Prehydrolysate was analyzed for the monometric sugar contents by high performance liquid chromatography. Enzymatic hydrolysis was carried out in 125-ml Erlenmeyer flasks. The enzyme used was Novo cellulast 1.5 L and B-glucosidase (Norozyme). Cellulase enzyme loading was 15 FPU/g substrate and B-glucosidase loading was 15 IU/g substrate. Enzymatic hydrolysis was performed in 0.05 M sodium citrate buffer at PH 4.8 at 50ºC on a rotary shaker for 70 hr.with agitation speed at 140rpm. The composition of bamboo samples were analysed following ASTM Standard methods. The sugar content of the liquid filtrate after pretreatment was determined by HPLC in water liquid chromatograph with refractive index detector. An Arninex HPX carbohydrate analysis column was used –cellulose and B -glycosidase were measured bx FPU and IU.

Resulls&Discussion

Table 1 shows the composition of raw material (bamboo). It was shown the glucan was the dominant component in bamboo, Least amount in composition were mannan, xylan, arabinan, galactan, accounted for more than 65% of the dry weight, which shows bamboo a good substracte for ethanol production. Cellulose and lignin contents were found to be in high end of the range. Xylose was the main sugar 89% for the hemicellulose fraction.

Table1. wet chemical analysis of bamboo.

Composition	%wt.dry basis
Glucan	40.7
Cellulose	40.7
Lignin	27.1
Hemicellulose	26.5
Xylan	23.6
Mannan	0.6
Ash	1.2
Arabinan	1.1
Galactan	1.2

Table2.Sugar yields from bamboo.

lignocellulosic	Temp.(°C)	Acid concentration(%w/w)	Residence time (min)	Total sugar yield (g/100g)
bamboo	120-140	0.6-1.2	30-90	4.3-8.5

From the dilute acid pretreatment, it was found that the important monomeric sugar to convert to ethanol is glucose, with recovery ranged from 0.75-3.50 g /100g glucose. Total sugar yields from bamboo is summarized in Table 2. The yield refers to total amount of sugars available after pretreatment and enzymatic hydrolysis from 100 g of raw material. Data show that total sugar yield from bamboo was rather small. This may be atlributed to some sugar degradation due to acid action. This table shows sugar yields from enzymatic hydrolysis of dilute acid pretreat lignocellulosic bamboo.

Conclusion

Potential use of bamboo as fuel source for bioethanol was considered in this study. Chemical characterization of the plant was conducted. Conversion of bamboo by dilute acid pretreatment to produce sugars was investigated. Composition of bamboo was rich in cellulose and hemicellulose fractions which were desirable fuel characteristics for ethanol production.

It was found that soft pretreatment conditions led to a sugar rich prehydrolyate. Dilute acid pretreatment of bamboo produced digestible residues and solubilised significant amounts of the hemicellulose frection. Maximum xylose yields could be obtained at severe pretreatment condition where relatively little amount of glucan was affected. Mild pretreatment condition at 30 min retention time 0.6% sulfuric acid concentration and 120ºC did not provide good solubilisation of hemicelluloses.

High enzymatic hydrolysis yield of 85 mg/g was achieved with increases in pretreatment time and sulfuric acid concentration, while pretreatment temperature was not found to play important role. Total sugar yields were relatively low, in comparison with other mainstream biomass feedstocks. Further improvements in terms of increased total reducing sugar yield may be necessary to increase final ethanol yield in the process.

Acknowledgments

This work was supported by the faculy of university of shahed.

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