Octa Journal of Biosciences
International peer-reviewed journal
Octa. J. Biosci. Vol. 2(2): 119-120

ISSN 2321 – 3663
Dec. 2014

Octa Journal of Biosciences

journal homepage: www.sciencebeingjournal.com

Short -Communication

Bioethanol Production From Wheat Straw By Popping Pretreatment

I Vinod Kumar[*1], P.K.Chauhan[2] and Virender Singh[3]

1. Dept. of Life Sciences and Chemistry, Beehive college of Advance studies, Dehradun, India
2. School of Bioengineering and Food Technology, Shoolini University, Solan, HP, India
3. Dept. of Microbiology, Himachal Institute of Life Sciences, Paonta Sahib, HP, India

ARTICLE INFO

Received 27 Jan. 2014
Revised 30 March 2014
Accepted 15 April 2014
Available online 25 Dec. 2014

Keywords: Wheat straw, Bioethanol , popping pretreatment, alkali, acid

Email:vinodkdhatwalia@gmail.com

ABSTRACT

Wheat straw is used as a raw material as it is the most widely grown in India. Conversion of wheat and rice straw biomass to fuel ethanol involves pretreatments followed by enzyme-catalyzed hydrolysis to generate fermentable sugars. Efficient pretreatment method can significantly enhance hydrolysis of biomass and thus reduce ethanol production cost. The objective of this study was to study the effect of popping pretreatment. Dilute sulfuric acid, alakili and popping methods are used for pretreatment in combination with enzymatic hydrolysis. These results indicate that popping pretreatment of wheat give the good results than as compared to other pretreatments alkali and acid.

INTRODUCTION

Excessive consumption of fossil fuels, particularly in large urban areas, has resulted in generation of high levels of pollution during the last few decades. The level of greenhouse gasses in the earth's atmosphere has drastically increased (Ballesteros et al 2006). Ethanol is one of the best tools to fight vehicular pollution, contains 35% oxygen that helps complete combustion of fuel and thus reduces harmful tailpipe emissions. It also reduces particulate emissions that pose a health hazard.

Bioethanol is currently produced primarily from sugar and starch sourced from crops (first-generation biomass) such as sugar cane, wheat and corn, which have a high concentration of sugar (Kim 2004, . Naik et al 2010). However, because these crops are also important food sources bioethanol produced from them can have a significant impact on food prices and food security (Naik et al 2010). But wheat straw has a high potential as sustainable biomass source in India based on its abundance and low cost. Wheat straw is a good raw material for ethanol production, since wheat straw has a rather high content of cellulose. The cellulose in biomass can be hydrolysed to sugars that can be fermented into ethanol. Wheat straw has a rather large content of cellulose, roughly 34 % (Alfaniet al 200).

India, with a GDP of about USD 475 billion, is the fifth largest economy in the world. Seventy two percent of India's people live in rural areas and about 70% earn their livelihood from agriculture. India's rate of economic development is affected, as it needs to import about 70% of its petroleum demand. The demand for bioethanol is increasing worldwide. It has been estimated that ethanol production rate by 2050 will be 50 times larger than the ethanol production of 2004 (Mangaraj et al 2013). The aim of this study was to the study the effect of popping pre-treatment of wheat straw on ethanol production.

MATERIALS AND METHODS

Raw material and popping pretreatment

Popping pretreatment given done by Seung Gon Wi et al (2013) method with some modification. Raw material and popping pretreatment wheat straw harvested in 20013 was chopped into small pieces of ~2 cm in length with a cutter and then kept refrigerated until use. Popping pretreatment was performed in a laboratory-scale cast steel container with a total volume of 3 L. The container was filled with 500 g of with wheat straw. Ad 1L water and directly heated with a gas burner at a rate of between 100°C for 20 min. Put it into the autoclave for (15 psi and 121 °C) for 20 min. After popping, the material was cooled to ambient temperature.

Pretreatment with dilute acid

Pretreatment with dilute acid has been the most widely used method for pretreatment of the lignocellulosic material. This method uses cheap chemicals, mild operating conditions and is simple to perform. In the pretreatment with dilute acid, 0.5–1.5% sulfuric acid solution is added to the biomass to hydrolyse hemicelluloses during 5–60 minutes at 130–200ºC. Higher temperatures require shorter time of pretreatment (Yang et al., 2009; Dien et al., 2006).

Pretreatment with alkali

Pretreatment with alkali removes lignin and part of the hemicellulose, thus increasing the accessibility of enzymes to cellulose in later phases of hydrolysis. This process uses alkali such as NaOH (3%) and temperatures of 120–180°C.

Enzymatic saccharification

Five grams of the delignified samples were taken in flask of 250ml capacity separately. The cellulase were used to treat substrates at substrate to enzyme ratio 1:14 (5 g substrate : 70 ml enzyme). The flasks were incubated at 50ºC in a water bath for 48h.

Test for Reducing Sugar

Qualitative test (Benedict) was used to confirm reducing sugars presence. Yellow color –shows the presence of low amounts of reducing sugars, orange color -moderate amounts of reducing sugars present, brown color shows presence of large amounts of non-reducing sugars.

Fermentation

Commercial pure-culture yeast Saccharomyces cerevisiae (Mitushi Pharma) was used. Yeast was activated by hydration in 0.1% sterile peptone pre-warmed to 370C, and then inoculated into the fermentation medium (0.25g/kg).

Analysis

A 4-mL fermentation broth was sampled. The sample was centrifuged at 10000 × g for 5 min. The precipitate was discarded. The supernatant was used to quantify ethanol by Gas chromatography (GC) .

RESULTS AND DISCUSSION

The substrate presented in this study was wheat straw pre-treated with acid, alkali and popping methods. Presence of brown color during Benedict test, it confirms presence of good reducing sugar in samples. The ethanol content of wheat straw was determined using GC after different pretreatment. The result was shown in table 1.

Results shows that popping up pretreatment yield high amount of ethanol (77.87 g/l), after that alkali shows yield (40.60 g/l) and minimum amount of ethanol yield shown by acid pretreated wheat straw. Our results supported the finding of Wi et al (2013) popping pretreatment of rice straw can effectively improve downstream saccharification and fermentation, important for bioethanol production. Pretreatment with alkali has been reported to give better ethanol yields than pretreatment with dilute acid. This is due to better fermentation efficiency, because formation of inhibitory byproducts is avoided. Downside of the method is a slightly lower sugar conversion rate. Pretreatment with alkali is best used for biomass with high lignin content (Gupta, 2008; Hamelinck et al., 2005; Mosier et al., 2005).

CONCLUSION

From the results we have concluded that the popping pretreatment of wheat give the good results than as compared to other pretreatment alkali and acid. Further studies are necessary to achieve an economical process.

REFERENCES

1. Ballesteros I, Negro MJ, Oliva JM, Cabanas A, Manzanares P, Ballesteros M (2006) Ethanol production from steam-explosion pretreated wheat straw. *Applied Biochemistry and Biotechnology,* 130:496-508.

2. Dien, B., Jung, H., Vogel, K., Casler, M., Lamb, J., Iten, L., Mitchell, R., Sarath, G., (2006). Chemical composition and response to dilute-acid pretreatment and enzymatic saccharification of alfaalfa, reed canarygrass and switchgrass. *Biomass Bioenergy*, 30, 880–891.

3. Gupta, R., (2008). Alkaline pretreatment of biomass for ethanol production and understanding the factors influencing the cellulose hyrdolysis, A Dissertation, Auburn University, Alabama, USA.

4. Hamelinck, C.N., Hooijdonk, G.V., Faaji, A. (2005). Ethanol from lignocellulosic biomass: technoeconomicperfomance in short-, middle- and long-term. *Biomass&Bioenergy*, 28, 384–410.

5. Kim S, Dale BE. (2004) Global potential bioethanol from wasted crops and crop residues. *Biomass Bioener*, 26:361–375.

6. Mosier, N., Wyman, C., Dale, B., Elander, R., Lee, Y., Holtzapple, Ladisch, M. (2005)Features of promising technologies for pretreatment of lignocellulosic biomass. *Bioresource Technology.* 96(6), 673–686.

7. Seung Gon Wi, In Seong Choi, Kyoung Hyoun Kim, Ho Myeong Kim and Hyeun-Jong Bae.(2013) Bioethanol production from rice straw by popping pretreatment. *Biotechnology for Biofuels*, 6:166.

8. Yang, Y., Sharma–Shivappa, R., Burns, J.C., Cheng, J.J., (2009). Dilute Acid Pretreatment of Oven-dried SwitchgrassGermplasms for Bioethanol Production. *Energy & Fuels*, 23, 3759–3766.

9. Naik SN, Goud VV, Rout PK, Dalai AK: Production of first and second generation biofuels: a comprehensive review. *Renew Sust Energ Rev,* 2010, 14:578–597.

10. Alfani, F.; Gallifuoco, A.; Saporosi, A.; Spera, A.; Cantarella, M. (2000). Comparison of SHF and SSF processes for the bioconversion of steam-exploded wheat straw. *Journal of Industrial Microbiology & Biotechnology*, 25 (4), 194-192.

11. S. Mangaraj , R. Singh and R.K. Pajnoo. (2013) Post Production system of Jatropha for use as Biodiesel. *Octa. J. Biosci.* 1(1): 85-97

Table 1 Ethanol yield after the fermentation of wheat Straw

Sample	Acid Pre-treatment **(g/L)**	Acid Pre-treatment **(%)**	Pretreatment Alkali **(g/L)**	Pretreatment Alkali **(%)**	Popping pretreatment **(g/L)**	Popping pretreatment **(%)**
Wheat Straw	32.58	3.2	40.68	4.6	77.87	7.7

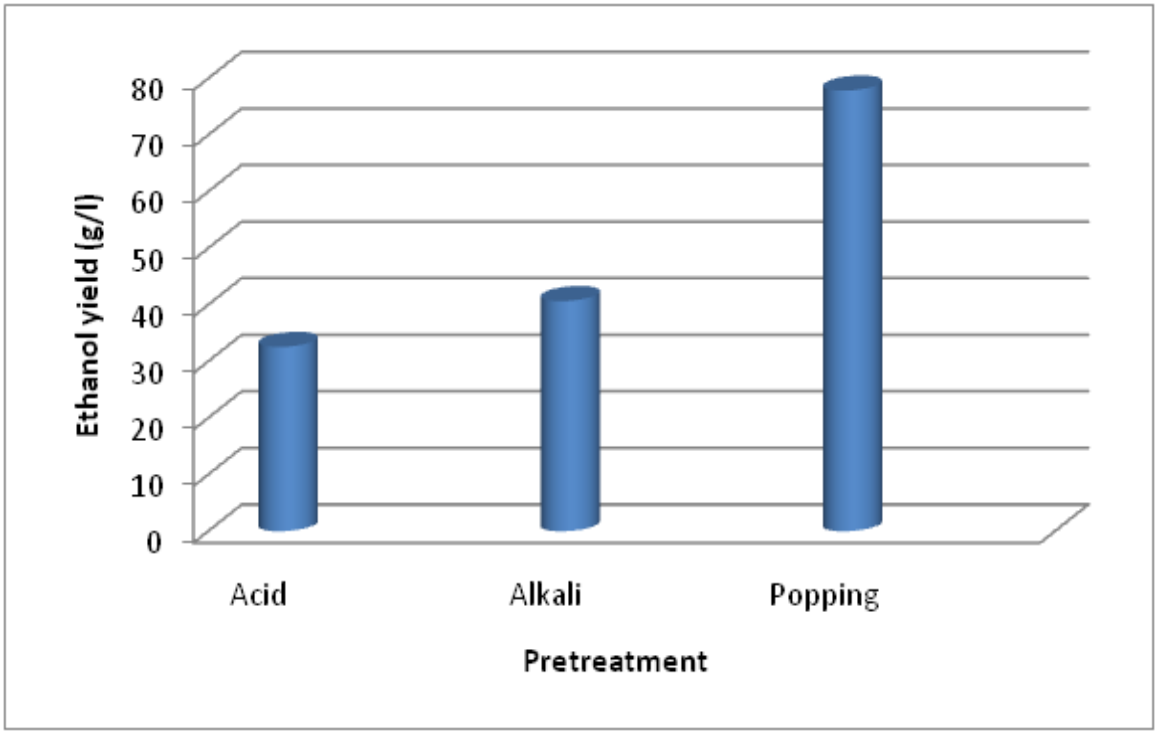

Fig. 1 Ethanol yield after the fermentation of wheat Straw