Ethanol Production by Synchronous Saccharification and Fermentation of Foodwastes

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Abstract

In the previous research about ethanol production, we confirmed that SFW(saccharified foodwastes) medium(0.56g-ethanol/g-glucose) is more efficient than YM medium(0.538g-ethanol/g-glucose). Ethanol production using SFW needs large enzyme cost due to the enzymatic hydrolysis of foodwastes, although the enzymes was obtained from our economical enzyme production methods, using the intact whole culture broth of *Trichoderma harzianum* FJ1. Therefore, in this research we used synchronous saccharification and fermentationmethod to produce ethanol using foodwastes. Ethanol production yield was 0.45g-ethanol/g-reducing sugar in synchronous saccharification and fermentation by a fed-batch mode.

Introduction

We are now faced with development of substitutable gases because of increasing request of energy, the limitation of fossil gases, and environment destruction (global warming, decreasing of ozone layer). Among these gases, ethanol is known as working replacement petroleum due to more favorable than others in the light of its function and economical efficiency[1,2].

In the previous research about ethanol production, we confirmed that SFW(saccharified foodwastes) medium(0.56g-ethanol/g-glucose) is more efficient than YM medium(0.538g-ethanol/g-glucose). Ethanol production using SFW needs large enzyme cost due to the enzymatic hydrolysis of foodwastes, althoughthe enzymes was obtained from our economical enzyme production methods, using the intact whole culture broth of *Trichoderma harzianum* FJ1.

Therefore, in this research we used synchronous saccharification and fermentation method with fed-batch mode to produce ethanol using foodwastes.

Material & Method

Food wastes were obtained from first student cafeteria in Chonnam National University. *Trichoderma harzianum* FJ1 in the culture for *saccharification* enzymes preparation and *Saccharomyces italicus* KJ for ethanol production were used. Strain KJ was cultivated under the conditions of 30℃, 100 rpm, anaerobic, pH 5.0, reducing sugar (RS) 10%. On the other hand, saccharification process to obtain SFW was performed at 50℃, 200 rpm. The biggest difference in two processeswas temperature. So we planed some experiment designs to overcome the temperature problem as follow: ① adaptation subculture of strain KJ at 40℃, ② 40℃ mutant guarantee by UV radiation, ③ kinetics investigation balancing saccharification velosity of food waste and consumption velocity of reducing sugar at 30, 35, 40℃.

Effect of enzyme concentration on saccharification reaction of foodwastes

Foodwaste 200g(water 80%), hydrolytic enzymes[1.0, 2.0, 3.0 U-amylase/ml]40ml, and 1% sodium azide solvent 3ml were mixed in 500ml Erlenmeyer flask. Reducing sugars concentrations were measured with 0, 0.5, 1, 2, 4, 8, 16, 24hr intervals.

Synchronous saccharification and fermentation(SSF)

The reducing sugar was firstly produced by reaction of foodwastes and the enzymes in 1L bioreactor during 4hr. And then *S. italicus* KJ of 1% was inoculated into the bioreactor. Foodwastes were supplied with 4hr interval in the SSF.

Results and discussion

1. composition of food wastes

By elementary analysis of foodwastes

C: 44.56 ± 0.30%, N: 2.373 ± 0.219%, C:N = 100 : 6.2

The foodwastes is estimated to be available for incubating microbiology due to nearness of C:N = 100 : 5

2. Effect of temperature on saccharification reaction and ethanol fermentation

The guarantying of mutant strain was ended in failure. At the temperature of 35℃, consumption rate of reducing sugar by ethanol fermentation was -3.88g/L/hr and production rate of reducing sugar by enzymatic hydrolysis of foodwastes was 5.84g/L/hr (Fig.1)

3. Effect of enzyme concentration on saccharification reaction of foodwastes

In the SSF, production and consumption of reducing sugars are at a equilibrium when the concentration of enzyme is 2.0U-amylase /ml (Fig 1, 2).

4. Interval of foodwastes supply in fed-batch of SSF

Fig. 2 showed concentration of RS and ethanol in fed-batch of SSF at the condition of 35℃, 2.0U/ml(amylase), supplying food waste with 4 hrs interval. The ethanol productionmode with 4 hrs interval is not desirable by excess of sugars. The most available supply interval is 12 hrs.

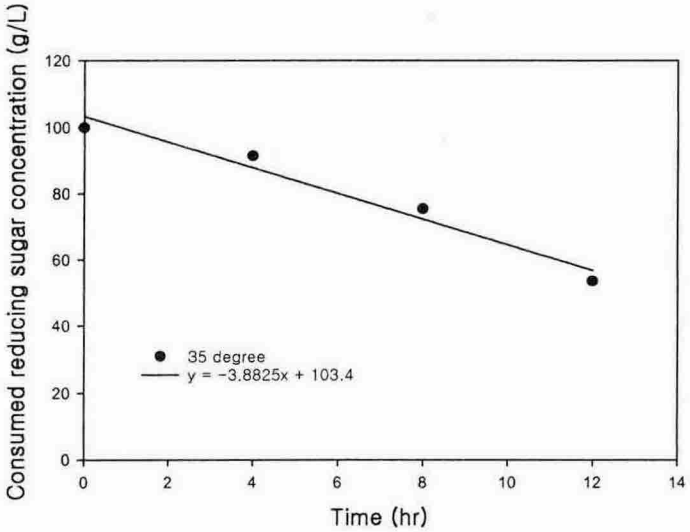

Figure 1. Consumption rate of reducing sugar SFW medium by ethanol fermentation at 35℃.

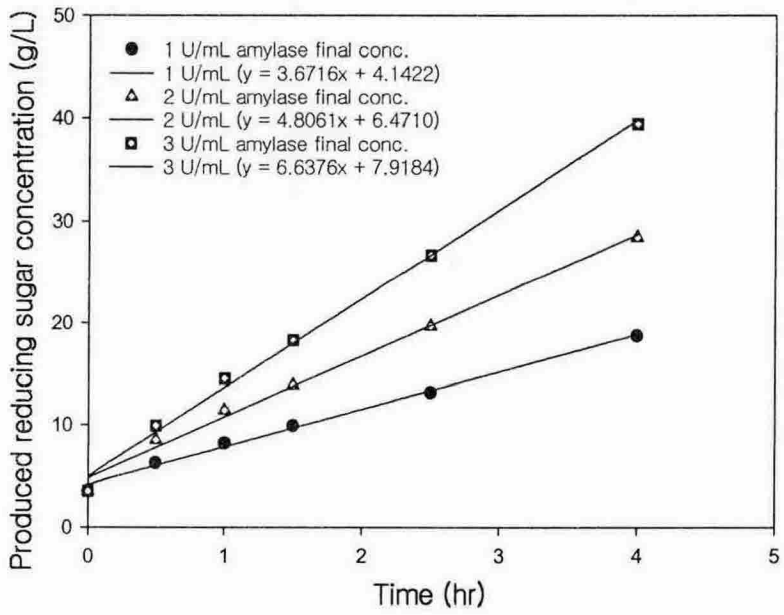

Figure 2. Production rate of reducing sugar in the conditions of amylse concentration, 1.0, 2.0, 3.0U/ml in SFW medium.

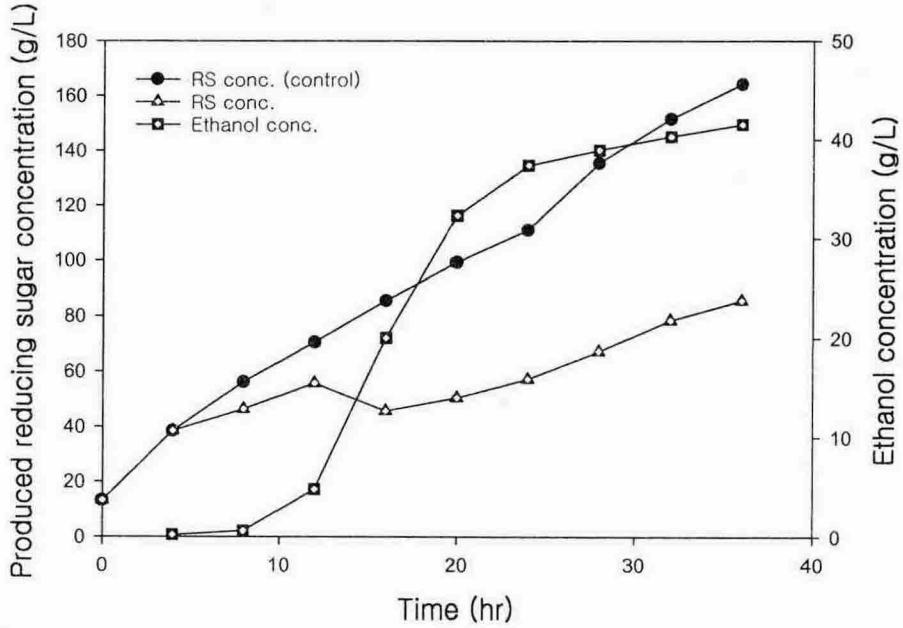

Figure 3. SSF using fed-batch culture mode supplying food wastes with 4-hrs interval. ↑ showed the addition times of foodwates in the SSF.

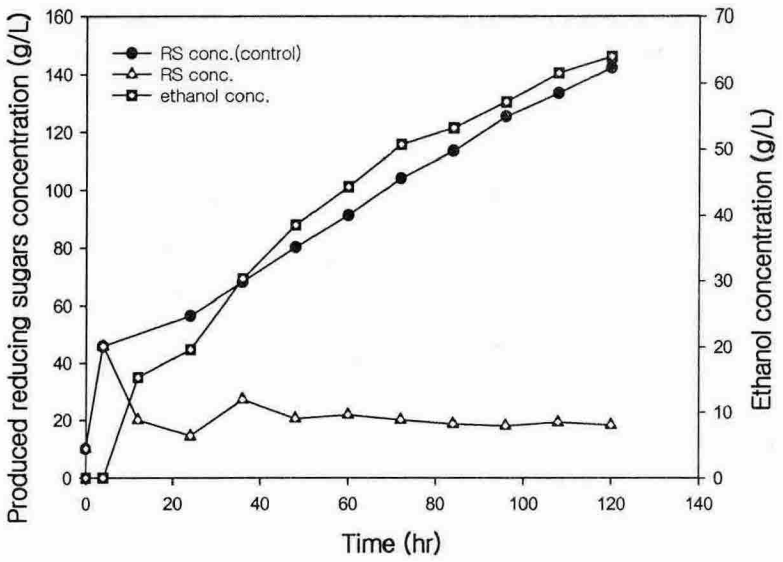

Figure 4. SSF using fed-batch culture mode supplying foodwastes with 12-hour interval. ↑showed the addition times of foodwastes in the SSF

4. Conclusion

In SSF using fed-batch culture mode supplying foodwastes with 12-hour interval during120 hrs, the concentration of reducing sugar of 18.3g/L, ethanol of 64g/L, and ethanol yield was 0.45g-ethanol/g-reducing sugar were respectively obtained.

5. Acknowlegment

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6. Reference

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