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Analysis of food waste as a substantial potential for biohydrogen production

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Abstract

Concern about climate change, dwindling petroleum reserves are fuelling resurgence in the search of alternatives, viz. renewable fuels. Hydrogen is one such possible candidate which is also regarded as the cleanest fuel with only water as the by–product.

Simple carbohydrates such as glucose and sucrose are ideal substrates for biological hydrogen production. However, pure carbohydrate sources are expensive raw materials. Hydrogen production from mixed organic waste is more realistic as it can meet the goal for waste reduction and energy production. Food waste (FW) has high hydrogen production potential because of its high content of organic matter and carbohydrates, but also of its easily hydrolyzable and biodegradable nature (Davila-Vazquez et al., 2008). Although food waste can be highly diverse, generally it is consisted mainly of starch, protein, and fat, with small amounts of cellulose and hemi–cellulose. The volatile solids to total solids ratio (VS/TS) is more than 80%. These volatile solids are quite biodegradable, of which 80 to 90% can be converted to biogas. In this study, the feasibility of biohydrogen production from enzymatic hydrolysis of food waste was investigated. Hydrolysis of food waste is considered as the rate limiting step in the overall anaerobic fermentation process. Food waste (FW) was collected from a canteen at IIT Guwahati. It mainly food remaining in plates after lunch consisted of boiled rice, dal and fried potatoes. Food waste was dried for 48 h in oven at 60^{o}C. After drying, food waste was grinded in powdered form. Commercial glucoamylase purchased from Rich Core Life Sciences (P) Ltd. was used for enzymatic hydrolysis of food waste. The activity of glucoamylase was specified to be 1,25,000–1,75,000 U/ml by the supplier (Youn et al., 2008).

The enzymatic hydrolysis of food waste was carried out using commercial glucoamylase enzyme obtained from Rich Core Life Sciences (P) Ltd. The hydrolysis was performed in incubator shaker (Orbitek, Scigenics Biotech) in 50 mM citrate phosphate buffer solution (pH 4.5) at 55^{o}C and 200 rpm. The concentration of pretreated biomass in reaction mixture was 7% w/v, with glucoamylase concentration of 175 FPU/mL biomass. The hydrolysis was carried out for 120 h. 0.5 mL samples of reaction mixture were withdrawn periodically during enzymatic hydrolysis and were analysed for release of sugar. Hydrolysis was terminated when glucose concentration in reaction mixture reached saturation. The mixture was centrifuged at 10,000 rpm for 15 min followed by filtration using Whatman No. 1 filter paper to obtain the liquid food waste hydrolysate. This hydrolysate was used as substrate for biohydrogen production. Notably, residual oil traces in food waste were also removed by this treatment.(Han et al., 2016)

Time profiles of reducing sugar in enzymatic hydrolysis of food waste are shown in **Fig. 1**. It could be seen from Fig.1 that the highest sugar yield was obtained for glucoamylase enzyme concentration of 5 µL in 100 mL reaction volume of the mixture. For all three enzyme concentrations used in this study (viz. 5, 10 and 100 µL), the reducing sugar concentration reached saturation after approx. 96 h of treatment. **Fig. 2** shows that hydrogen production increases from 3 h to 18 h and after that its production remained constant.

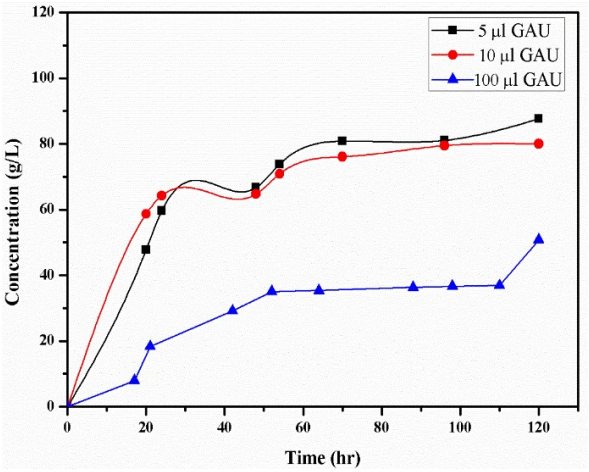

Figure1. Enzymatic hydrolysis of food waste

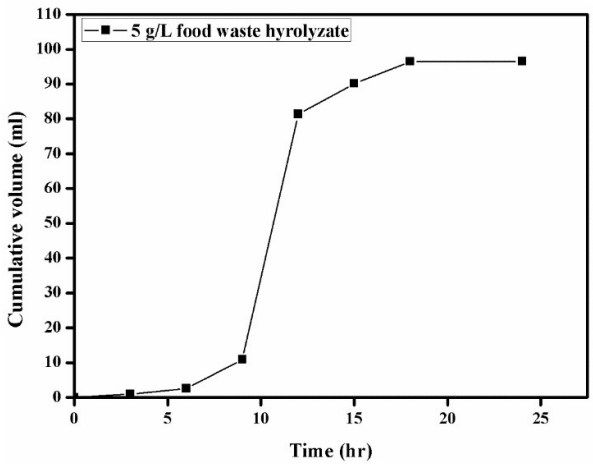

Figure.2 Time profile of cumulative hydrogen production by *C. pasteurianum* at concentration of food waste hydrolyzate (5 g/L) as substrate

References

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