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Open fermentative production of fuel ethanol from food waste by an acid-tolerant mutant strain of *Zymomonas mobilis*

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HIGHLIGHTS

- An economical bioprocess for ethanol production from food waste was developed.
- Open fermentation by employing acid-tolerant *Z. mobilis* ZMA7-2 was achieved.
- Bench scale ethanol fermentation and cell reusability was feasible.
- *Z. mobilis* ZMA7-2 is an ideal organism for food waste based ethanol production.

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ABSTRACT

The aim of present study was to develop a process for open ethanol fermentation from food waste using an acid-tolerant mutant of *Zymomonas mobilis* (ZMA7-2). The mutant showed strong tolerance to acid condition of food waste hydrolysate and high ethanol production performance. By optimizing fermentation parameters, ethanol fermentation with initial glucose concentration of 200 g/L, pH value around 4.0, inoculum size of 10% and without nutrient addition was considered as best conditions. Moreover, the potential of bench scales fermentation and cell reusability was also examined. The fermentation in bench scales (44 h) was faster than flask scale (48 h), and the maximum ethanol concentration and ethanol yield (99.78 g/L, 0.50 g/g) higher than that of flask scale (98.31 g/L, 0.49 g/g). In addition, the stable cell growth and ethanol production profile in five cycles successive fermentation was observed, indicating the mutant was suitable for industrial ethanol production.

1. Introduction

In the past decades, renewable biomass-based energy production has gained great interest due to the growing global energy demand and environmental pollution associated with the fossil fuels (Ma et al., 2014a; Ma and Ruan, 2015). Among them, bioethanol as one of the most promising alternative to those fossil fuels has been intensively studied and its production is increasing over the years, reaching the level of 100 billion liters during the year 2013 (Ho et al., 2014). Traditionally, bioethanol is produced mainly from the first generation feedstocks i.e. sugar (sugar cane and sugar beet) or starch energy crops (corn, wheat and rice). But the crop-based ethanol production led to the problems of crop competition and landfill use conflict in addition to the high production cost hindered the global application of bioethanol (Ho et al., 2014; Choi et al., 2015; Horisawa et al., 2015). To solve these problems, the research emphasis has then moved forward to the ethanol production using the second generations feedstocks comprise of non-food lignocellulosic biomass such as agricultural byproducts, forestry residues or municipal waste (Choi et al., 2013; Ho et al., 2014; Saha et al., 2015). Even though lignocellulosic biomass is the most abundant and renewable resource suitable for bioethanol production, their variable composition and high lignin content making the pretreatment process very difficult and costly, thus limit its industrial scale production. (da Costa et al., 2015; Ho et al., 2013).

Food waste is organic solid wasted discharged from sources including food processing plants, household kitchens and restaurants (Kiran and Liu, 2015). Over a billion tons of food waste is generated per year, and only in Japan, the annual generation of food

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