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Biosynthesis of xanthan gum by *Xanthomonas campestris* LRELP-1 using kitchen waste as the sole substrate

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2,4-Dinitrophenylhydrazone (PubChem CID: 9659690)
Furfural (PubChem CID: 7362)
5-Hydroxymethylfurfural (PubChem CID: 237332)

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ABSTRACT

Herein, we report the production of xanthan gum by fermentation using kitchen waste as the sole substrate. The kitchen waste was firstly pretreated by a simple hydrolysis method, after which the obtained kitchen waste hydrolysate was diluted with an optimal ratio 1:2. In a 5-L fermentor, the maximum xanthan production, reducing sugar conversion and utilization rates reached 11.73 g/L, 67.07% and 94.82%, respectively. The kinetics of batch fermentation was also investigated. FT-IR and XRD characterizations confirmed the fermentation product as xanthan gum. TGA analyses showed that the thermal stability of the xanthan gum obtained in this study was similar to commercial sample. The molecular weights of xanthan gum were measured to be 0.69–1.37 × 10^6 g/mol. The maximum pyruvate and acetyl contents in xanthan gum were 6.11% and 2.49%, respectively. This study provides a cost-effective solution for the reusing of kitchen waste and a possible low-cost approach for xanthan production.

1. Introduction

Xanthan gum is a microbial exopolysaccharide produced by *Xanthomonas campestris*. It is a hetero-polysaccharide with repeated pentasaccharide units consisting of two molecular structures of glucose, mannose and one unit of glucuronic acid (Gilani, Najafpour, Heydarzadeh, & Zare, 2011). Xanthan gum is widely used in food, cosmetic, oil recovery and pharmaceutical industries owing to its excellent rheological properties, pseudoplasticity, thickening property and stability to heat, acid and alkali (Lopes et al., 2015; Niknezhad, Asadollahi, Zamani, & Biria, 2016; Rosalam & England, 2006; Sand, Yadav, & Behari, 2010). It is estimated that approximately 30,000 tons of xanthan was produced annually and the consumption of xanthan also increased gradually (Ben Salah et al., 2010; Palaniraj & Jayaraman, 2011). Currently, commercial xanthan gum is produced by fermentation using glucose and sucrose as carbon source. Due to the high cost of glucose and sucrose (US$ 400–600/ton), the produced xanthan gum possesses a high price of US$ 4000–5000/ton (Gunasekar, Reshma, Treesa, Gowdhaman, & Ponnusami, 2014; Yoo & Harcum, 1999). Therefore, it is of great importance to find alternative low-cost fermentation substrates for xanthan gum production.

Various low-cost materials have been adopted to replace glucose and sucrose for xanthan production, such as waste sugar beet pulp, tapioca pulp, residue of apple juice, chestnut extract and cheese whey, etc. (Druzian & Pagliarini, 2007; Liakopoulou-Kyriakides, Psomas, & Kyriakidis, 1999; Niknezhad, Asadollahi, Zamani, Biria, & Doostmohammadi, 2015; Woiciechowski, Soccol, Rocha, & Pandey, 2004; Yoo & Harcum, 1999). However, additional nutrients are required in most cases. For example, yeast extract and several salts were added to the medium when tapioca pulp

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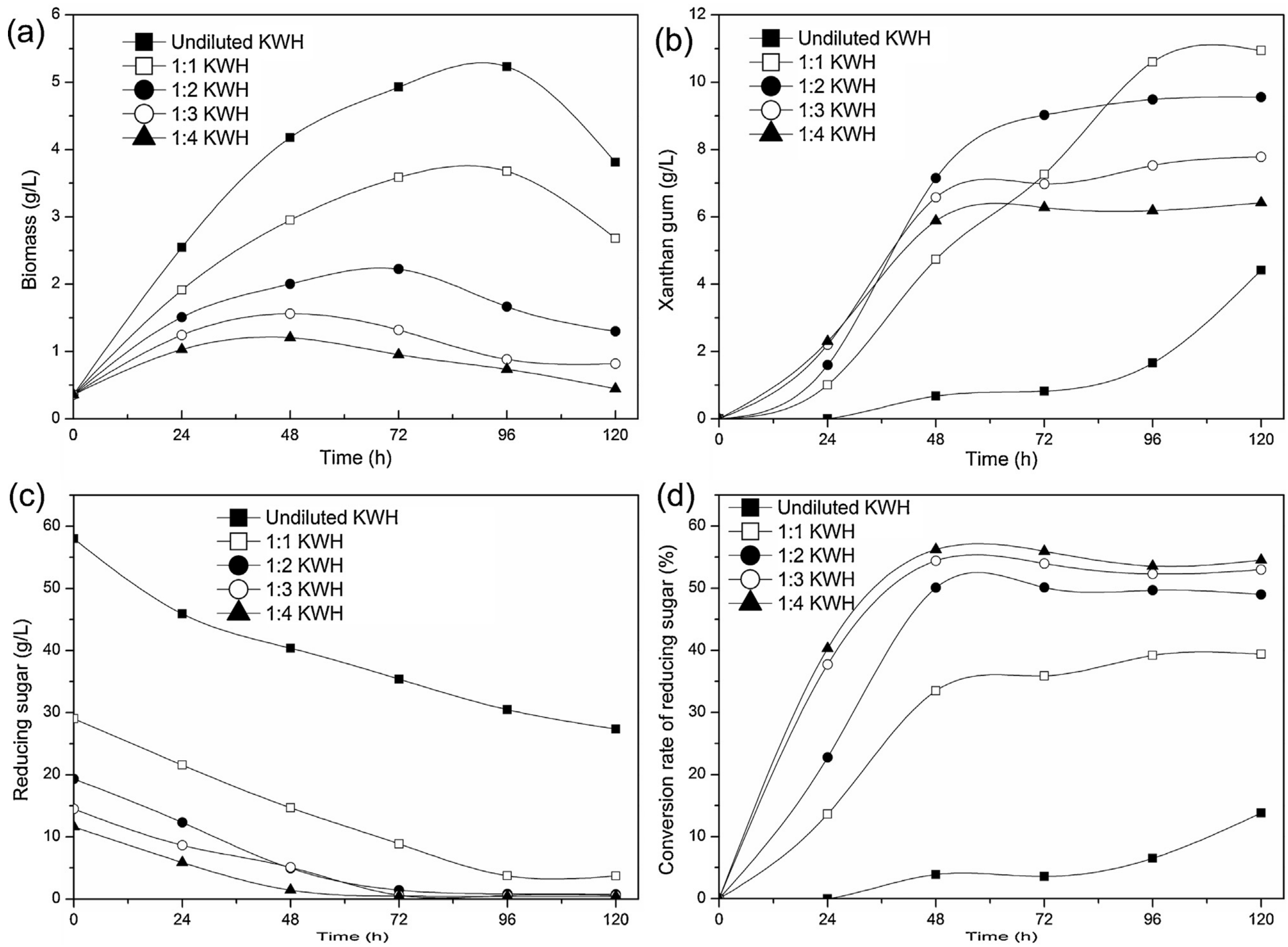

Fig. 1. Effect of dilution of KWH on growth of *X. campestris* (a), product formation (b), reducing sugar concentration (c) and reducing sugar conversion (d) in shaking-flask experiments.

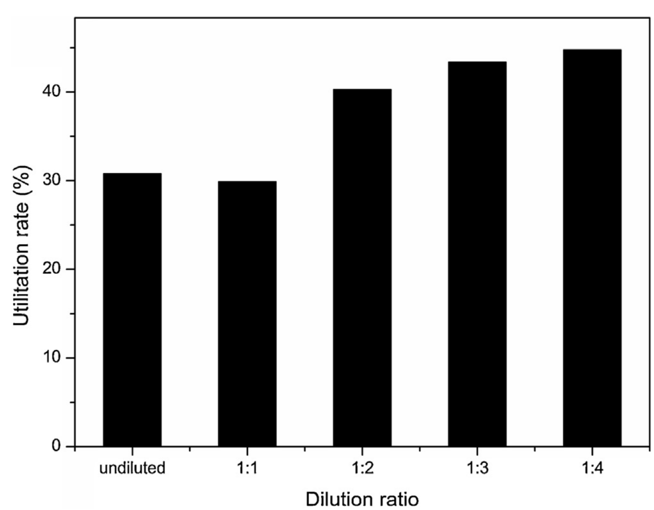

Fig. 2. Effect of dilution of KWH on crude Protein utilization in shaking-flask experiments.

was used as the fermentation substrate, which will increase the cost of fermentation. Thus, the utilization of low-cost material as sole substrate is desirable.

About one third of food for human consumption would be lost or become kitchen waste (KW) throughout the food supply chain (Uçkun Kiran, Trzcinski, & Liu, 2015). The amount of KW in China increases rapidly as the population is growing fast and the catering industry is developing swiftly (Li & Jin, 2015). It was reported that more than 500 ton of KW would be produced every day in the urban center of Chengdu, China. As one type of complex biomass with high organic and moisture content, KW can be rotten easily, which will pose threat to the environment if not being disposed appropriately (Nishio & Nakashimada, 2007). Currently, most of KW is treated by landfilling, incineration or serving as feeding materials to animals.