



Production of succinic acid by engineered *E. coli* strains using soybean carbohydrates as feedstock under aerobic fermentation conditions



Chandresh Thakker^a, Ka-Yiu San^{b,c}, George N. Bennett^{a,*}

^a Department of Biochemistry and Cell Biology, Rice University, Houston, TX, USA

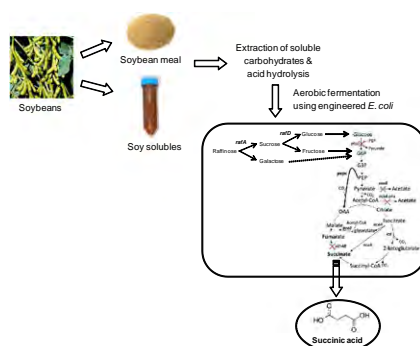
^b Department of Bioengineering, Rice University, Houston, TX, USA

^c Department of Chemical and Biomolecular Engineering, Rice University, Houston, TX, USA

HIGHLIGHTS

- ▶ We engineered *E. coli* to metabolize soluble sugars derived from soybean to succinate.
- ▶ Acid hydrolysate of soy oligosaccharides showed efficient succinate production.
- ▶ *E. coli* strains simultaneously fermented multiple sugars of soybean to succinate.
- ▶ 36 g/L succinate produced in aerobic shake flask using soybean feedstock sugars.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 25 May 2012

Received in revised form 24 August 2012

Accepted 29 October 2012

Available online 7 November 2012

Keywords:

Succinate

Escherichia coli

Aerobic fermentation

Soybean carbohydrates

Soy solubles

ABSTRACT

Escherichia coli strains HL2765 and HL27659k harboring pRU600 and pKK313 were examined for succinate production under aerobic conditions using galactose, sucrose, raffinose, stachyose, and mixtures of these sugars extracted from soybean meal and soy solubles. HL2765(pKK313)(pRU600) and HL27659k(pKK313)(pRU600) consumed 87 mM and 98 mM hexose of soybean meal extract and produced 83 mM and 95 mM succinate, respectively. While using soy solubles extract, HL2765(pKK313)(pRU600) and HL27659k(pKK313)(pRU600) consumed 160 mM and 187 mM hexose and produced 158 mM and 183 mM succinate, respectively. Succinate yield of HL2765(pKK313)(pRU600) was low as compared to that of HL27659k(pKK313)(pRU600) while using acid hydrolysate of soybean meal or soy solubles extracts. Maximum succinate production of 312 mM with a molar yield of 0.82 mol/mol hexose was obtained using soy solubles hydrolysate by HL27659k(pKK313)(pRU600). This study demonstrated the use of soluble carbohydrates of the renewable feedstock, soybean as an inexpensive carbon source to produce succinate by fermentation.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Succinic acid has been considered an important specialty chemical that can be produced by microorganisms. However, the placement of this molecule on the US Department of Energy (DOE) list of

twelve platform chemicals from biomass (Werpy and Petersen, 2004) has generated widespread attention toward biobased succinate manufacturing (McKinlay et al., 2007). Various valuable molecules derived from succinic acid by known chemical processes are 1,4-butanediol, maleic anhydride, succinimide, 2-pyrrolidinone, and tetrahydrofuran; all of which have large markets and can be converted to a wide range of other valuable molecules for use in polymers (Xu and Guo, 2010), industrial solvents, and specialty chemicals, for example, biodegradable succinate esters (Budarin et al., 2007; Zeikus et al., 1999). Succinate is also used as a flavoring

* Corresponding author. Address: Department of Biochemistry and Cell Biology, MS-601, Rice University, 6100 Main Street, Houston, TX 77005-1892, USA. Tel.: +1 713 348 4920; fax: +1 713 348 5154.

E-mail address: gbennett@rice.edu (G.N. Bennett).