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Review

Butanol production from renewable biomass by clostridia

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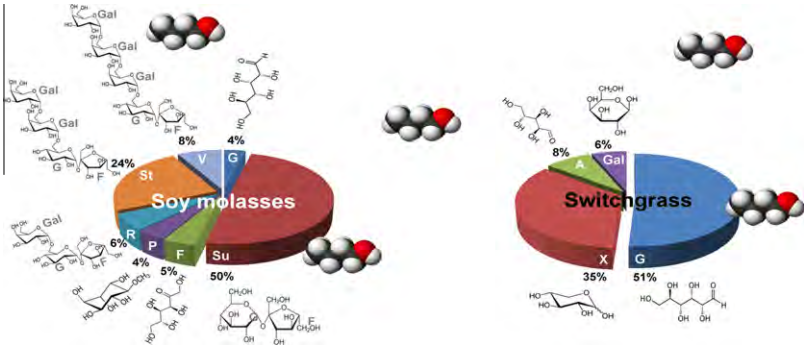
HIGHLIGHTS

- Butanol is an important industrial chemical as well as an advanced biofuel.
- We review the use of various carbon sources on fermentation performance.
- We review advanced fermentation and recovery processes for butanol production.

GRAPHICAL ABSTRACT



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ABSTRACT

Global energy crisis and limited supply of petroleum fuels have rekindled the worldwide focus towards development of a sustainable technology for alternative fuel production. Utilization of abundant renewable biomass offers an excellent opportunity for the development of an economical biofuel production process at a scale sufficiently large to have an impact on sustainability and security objectives. Additionally, several environmental benefits have also been linked with the utilization of renewable biomass. Butanol is considered to be superior to ethanol due to its higher energy content and less hygroscopy. This has led to an increased research interest in butanol production from renewable biomass in recent years. In this paper, we review the various aspects of utilizing renewable biomass for clostridial butanol production. Focus is given on various alternative substrates that have been used for butanol production and on fermentation strategies recently reported to improve butanol production.

1. Introduction

Butanol is an important industrial chemical and is also considered as a superior liquid fuel with a potential to replace gasoline (Dürre, 2007; Lee et al., 2008; Papoutsakis, 2008). Research effort towards the efficient production of butanol from sustainable and renewable carbon sources has steadily been progressing. Based on advances in biotechnology and process engineering, new fermentation processes are being developed for converting the abundantly available biomass to butanol (Dürre, 2007; Lee et al., 2008; Papoutsakis, 2008). Butanol has traditionally been produced by anaerobic fermentation of sugar substrates using various species of solventogenic clostridia (Jones and Woods, 1986). Except for the solventogenic clostridia, it is believed that no genus among the bacteria, archea and eucarya is efficient enough to naturally produce butanol (Qureshi et al., 2008).

Treatment of biomass for the extraction of fermentable sugars results in a mixture of sugar substrates, mainly pentoses, hexoses, and disaccharide. *Clostridium* sp. are known to have the capability of utilizing simple and complex sugars, including both pentose and

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