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Production and evaluation of biodiesel and bioethanol from high oil corn using three processing routes

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HIGHLIGHTS

- ▶ Bioethanol and biodiesel were produced from six high oil corn (oil content: 4–21%).
- ▶ We compare three processing routes with the yield of ethanol and biodiesel.
- ▶ M–F–T and S–T|F route produce the highest ethanol and biodiesel yield, separately.
- ▶ M–F–T route is suitable for producing ethanol and biodiesel for corn with small germ.
- ▶ S–T|F route is suitable for producing ethanol and biodiesel for corn with large germ.

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ABSTRACT

Six Korea high oil (KHO) corn varieties varying in germ and endosperm size and oil content (4–21%, wet basis) were subjected to three sequential combinations of milling (M), germ separation (S), fermentation (F), and in situ transesterification (T) to produce bioethanol and biodiesel. Production parameters including saccharification, bioethanol yield, biodiesel yield and composition, and conversion rate were evaluated. The effects of the contents of germ, endosperm size, oil, and non-oil solid mass on the production parameters strongly depended on the processing routes, namely M–F–T, M–T–F, and S–T|F. The M–F–T route produced the highest bioethanol yield while the S–T|F route produced the highest biodiesel yield. The in situ transesterification reaction, if proceeded before fermentation, reduced the bioethanol yield while fermentation and/or presence of endosperm reduced the biodiesel yield.

1. Introduction

The world must seek alternative liquid fuels to replace fossil fuels in the near future because of the rapid depletion and eventual end of fossil energy sources (Pimentel and Patzek, 2005). Ethanol (ethyl alcohol, bioethanol) and biodiesel (fatty acid methyl ester or FAME) are two most commonly available commercial renewable liquid transportation fuels. Ethanol may be used as a fuel or as a gasoline enhancer (Sánchez and Cardona, 2008). Many countries have implemented or implementing programs for addition of ethanol to gasoline (Sánchez and Cardona, 2008). The fuel ethanol can be produced from energy crops such as corn (Pimentel and Patzek, 2005) and lignocellulosic biomass such as wood using fermentation (Hamelinck et al., 2005).

Biodiesel, also named as fatty acid methyl ester (FAME), is another kind of clean fuel and is safe for use in conventional diesel engines. It offers the same performance and engine durability as petroleum diesel fuel. In the United States, biodiesel is produced mainly from oil extracted from soybeans (Chisti, 2007) via transesterification (Van Gerpen, 2005). Other sources of commercial biodiesel include canola oil (Dizge and Keskinler, 2008), animal fat, palm oil, corn oil, waste cooking oil (Ma and Hanna, 1999) and jatropha oil (Barnwal and Sharma, 2005).

Corn has been traditionally regarded as the main ethanol feedstock in US (Baker and Zahniser, 2006). Corn is not considered a viable source of lipids for biodiesl production because of its low oil or lipid content, in the range of 2–4%, in typical corn kernel (Duckett et al., 2002), which is much lower than soybean (15–20%). Corn oil

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