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Cogeneration of biodiesel and nontoxic rapeseed meal from rapeseed through in-situ alkaline transesterification

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HIGHLIGHTS

- ▶ Biodiesel and detoxified rapeseed meal was produced by in-situ transesterification.
- ▶ The conversion rate of rapeseed oil into FAME was 98%.
- ▶ The glucosinolate content in rapeseed meal was reduced to 0.07%.
- ▶ The detoxified rapeseed meal can be used as a source of protein in animal feed.

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ABSTRACT

In-situ alkaline transesterification of rapeseed oil with methanol for the production of biodiesel and non-toxic rapeseed meal was carried out. Water removal from milled rapeseed by methanol washing was more effective than vacuum drying. The conversion rate of rapeseed oil into FAME was 92%, FAME mass was 8.81 g, glucosinolates content in remaining rapeseed meal was 0.12% by methanol washing, while by vacuum drying the values were 46%, 4.44 g, 0.58%, respectively. In the presence of 0.10 mol/L NaOH in methanol, with methanol/oil molar ratio of 180:1 and a 3 h reaction at 40 °C, a conversion rate of 98% was achieved, and the glucosinolates content was reduce to 0.07%, a value which below the GB/T 22514-2008 standard in China. Thus the rapeseed meal can be used as a source of protein in animal feed. The FAME prepared through in-situ alkaline transesterification met the ASTM specifications for biodiesel.

1. Introduction

Biodiesel (fatty acid methyl esters, FAME) is a clean-burning, renewable fuel which is made from vegetable oils or animal fats with a short-chain alcohol by transesterification in the presence of a catalyst such as acid, alkali or an enzyme (Soares et al., 2012; Li et al., 2012; Azocar et al., 2011). At present, the predominant raw material for biodiesel production is semi-refined or refined vegetable oil. Its relatively high costs render the resulting fuels unable to compete with petroleum-derived fuel.

Contemporary production processes for refined vegetable oil involve extracting triglycerides (TG) from oilseeds by using solvents, degumming and refining. In contrast, in-situ transesterification (Qian et al., 2008; Qian and Yun, 2009; Hass et al., 2004; Carrapiso and Garia, 2000; Lei et al., 2010; Xu and Mi, 2011; Kasim et al., 2010) utilizes the original agricultural products as the source of triglycerides for direct transesterification, eliminates costly solvent extraction and oil refining processes and works with virtually any lipid-bearing material. Thus, this method could reduce biodiesel production time, maximize alkyl ester yield, reduce the use of reagents and solvents and reduce waste.

Rape is cultivated throughout the world for the production of vegetable oil, animal feed and biodiesel (Shin et al., 2012; Aydin and Llkilic, 2011; Tang et al., 2011). The seeds contain about 40% oil, and a meal with about 38–43% protein is obtained after extraction of the oil. Rapeseed oil is the preferred oil stock for biodiesel production because rape produces more oil per unit of land area than other crops. Rapeseeds could also be a significant source of protein if it were not for their content of toxic glucosinolates that can cause thyroid enlargement, liver damage, and even death of animals (Vermorel et al., 1987; Bourdon and Aumaitre, 1990; McMillan et al., 1986). According to GB/T 22514-2008 standard in China, feed grade rapeseed meal should not contain more than 0.34% glucosinolates. Thus, it is necessary for rapeseed meal to

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