Short Communication

Biodiesel production from Palm oil using calcined waste animal bone as catalyst

Asir Obadiah a, Gnanadurai Aji Swaroopab, Samuel Vasanth Kumar a,⇑, Kenthorai Raman Jeganathanc, Alagunambi Ramasubbud

a Department of Chemistry, Karunya University, Coimbatore 641114, Tamilnadu, India
b Department of Biotechnology, Karunya University, Coimbatore 641114, Tamilnadu, India
c Novozymes South Asia Pvt. Ltd., Bangalore 560066, India
d Post Graduate and Research Department of Chemistry, Govt. Arts College (Autonomous), Coimbatore, 641018, Tamilnadu, India

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Abstract

Waste animal bones was employed as a cost effective catalyst for the transesterification of palm oil. The catalyst was calcined at different temperatures to transform the calcium phosphate in the bones to hydroxyapatite and 800 °C was found to give the best yield of biodiesel. The catalyst was characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), energy dispersive spectrometry (EDS) and Fourier transform infrared spectrometry (FT-IR). Under the optimal reaction conditions of 20 wt.% of catalyst, 1:18 oil to methanol molar ratio, 200 rpm of stirring of reactants and at a temperature of 65 °C, the methyl ester conversion was 96.78% and it was achieved in 4 h. The catalyst performed equally well as the laboratory-grade CaO. Animal bone is therefore a useful raw material for the production of a cheap catalyst for transesterification.

1. Introduction

The transesterification of vegetable oils with methanol for the production of biodiesel using homogeneous catalysts requires several refining processes such as neutralization with acids. The formation of soap leads to difficulties in separating of the FAME from the reaction mixture. Low-grade glycerol is produced, the homogeneous catalyst is difficult to recycle, and potentially environmentally hazardous waste water is generated (Sharma and Singh, 2009). For these reasons, heterogeneous catalysts have attracted attention due to the elimination of neutralization, lack of toxicity, ability to withstand high temperatures, and ease of recycling. Although heterogeneous catalysis simplifies biodiesel production thereby lowering its production costs, the relatively low activity requires high catalyst loadings and long reaction times. Therefore, preparation of cost-effective heterogeneous catalysts with high activity is required for the production of biodiesel (Serio et al., 2008).

CaO is an environmental friendly material useful as a basic oxide catalyst. Ca(NO3)2, CaCO3, CaPO4 and Ca(OH)2 are raw materials to produce CaO, but natural sources such as egg (Empikul et al., 2010; Cho and Seo, 2010), shrimp (Yang et al., 2008),), oyster (Nakatan et al., 2009), and crab and cockle shells (Boey et al., 2011) have also been employed. Animal bone can also be a raw material. Calcium phosphate is the main component of bone and can be transformed to hydroxyapatite which has relatively high catalytic activity, good thermal and chemical stability, and can make the production of biodiesel environmentally friendly. In the present investigation, the bone-derived catalysts were characterized and utilized in the production of biodiesel using palm oil and methanol. Performance of the prepared catalyst was compared with that of laboratory grade CaO normally employed for base catalyzed transesterification. Reusability of the catalyst was also tested.

2. Methods

2.1. Materials

Waste animal bones were obtained from butcher shops in Coimbatore, India. Chemicals used were commercial CaO, acetone, sodium sulfate (Merck, Germany), anhydrous methanol (Sigma Aldrich), palm oil (Ruchi Soya Industries Limited), and FAME Internal standards C4–C24 (Sigma Aldrich). The Joint Committee on Powder Diffraction Standards (JCPDS) for calcium phosphate and calcium hydroxyapatite are JCPDS card no. # 23-0871 and 89-6439, respectively.

2.2. Catalyst preparation

Bone powder referred to as “milled animal bone” was prepared directly from bone without digestion/reprecipitation steps by