Waste marine barnacles as solid catalyst for methyl ester preparation using catfish (*Pangasius*) fat as feedstock

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Introduction

The growing awareness concerning the environmental issues on energy supply and usage have recently been the topic of interest in research. Among the various alternative energy discovered, biodiesel is one of the promising blended fuel to substitute petroleum derived diesel which offers friendly and sustainable environment. Boey et al, 2011; Boey et al, 2009; Nakatani et al, 2009 and Obadiah et al, 2012 revealed that many type of heterogeneous catalyst from waste, such as waste egg, crab, and oyster shells; bone and ash. Barnacle is successful creatures with abundant and diverse populations. Scientists have identified about 1,445 living species, of which 900 are barnacle. Their abundance can create serious and expensive fouling problems on ship bottoms, buoys and pilings. Astachov et al, 2011 stated that, in less than two years, 10 tons of barnacle can become attached to a tanker. In the present work, the transesterification catfish fat using barnacle as a catalyst was attempted.

Materials and methods

Materials

The raw material used in this work is catfish fat was collected from restaurant in Gambang, Malaysia. The barnacle shell was obtained from Tanjung Lumpur beach. The chemicals were purchased from Sigma-Aldrich company (Switzerland) include methyl heptadecanoate as an internal standard GC grades (> 99.1%). Methanol (anhydrous, ≥ 99.8%), hexane (anhydrous, ≥ 99.8%) was purchased from Hamburg (Germany).

Preparation and characterizations shells as catalysts and oil from catfish

The shell was cleaned using water to remove dirt and fibrous matters. Then the shells were dried in an oven at 105 °C. The shell was then ground in a pestle and mortar to obtain the gross powder and further fine ground with a dry-mill blender and sieved through 75 μm mesh before being subjected to heat treatment in furnace at 900 °C. Catfish fat was obtained from local restaurant in Gambang, Malaysia. The CaO was identified by X-ray diffraction (Rigaku), FT-IR (PerkinElmer Spectrum 100), FE-SEM with electron dispersive X-ray (EDX) (JSM-7800F). The catalyst was examined by thermogravimetric analysis (TGA).

Transesterification

The conversion of used catfish oil to biodiesel was performed in a 50 ml 2-neck round bottom flask equipped with a reflux condenser and magnetic stirrer. Biodiesel was isolated by centrifuged at 4000 rpm for 5 min, to further separate the layers (methyl ester, glycerol and catalyst, and then excessive amount of methanol) was evaporated before the chromatographic analysis. The concentration of methyl ester (ME) in the sample was quantified using GC-FID (Agilent 7890A) by following the European procedure EN 14214.

Results and discussion

X-Ray diffraction and electron dispersive X-ray (EDX) result show that, upon thermal activation, the shell transformed into CaO, the active ingredient that catalyzes the reaction. In addition, the result showed that the methyl esters content of barnacle was achieved at 93.6 ± 0.03 respectively with the 3 h reaction duration at 65 °C. Optimization of reaction parameters revealed that MeOH:oil, 12:1; catalyst, 4 wt.% as optimal reaction conditions of both catalyst. Figure below show the methyl ester conversion with different type of optimizations.

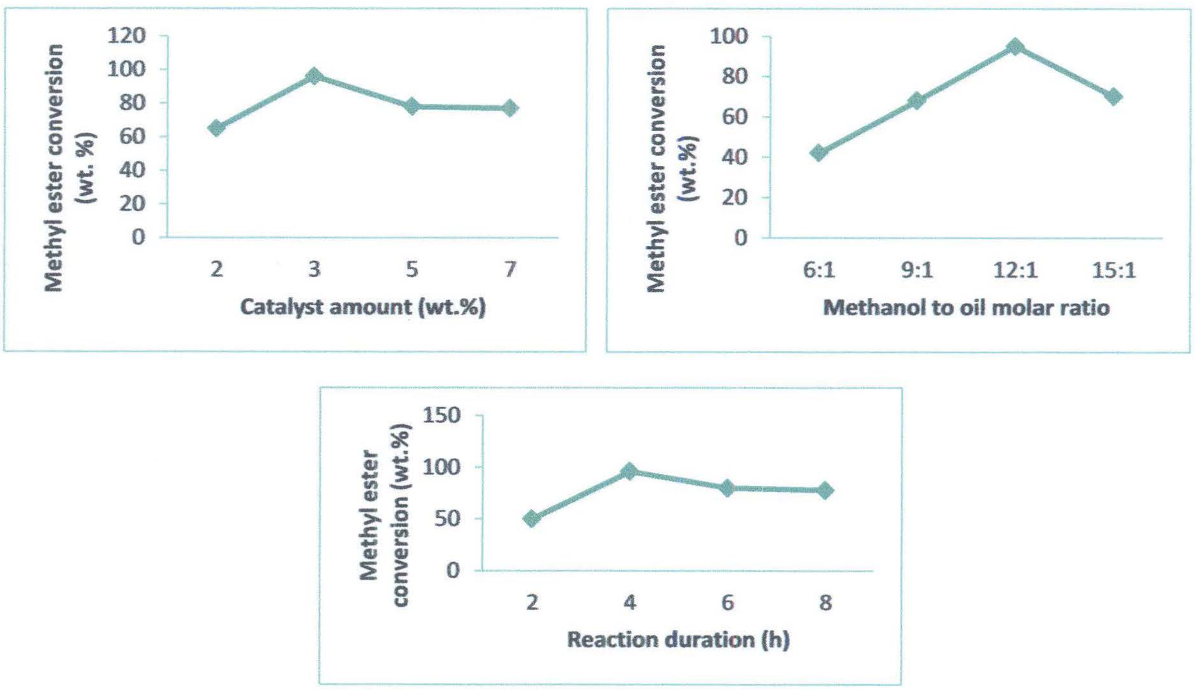

Figure 1: Effect of catalyst amount, methanol to oil molar ratio and reaction duration for methyl ester conversion

Conclusion

Methyl esters (ME) content of barnacle was at 93.6 ± 0.3 with the 3 h reaction duration at 65 °C. Optimization of reaction parameters revealed that MeOH: oil, 12:1; catalyst, 4 wt. % as optimal reaction conditions.

Acknowledgement

The authors are thankful to the Ministry of Higher Education, Malaysia, and Universiti Malaysia Pahang for funding the research project under MTUN COE Research Grant (RDU121207 and RDU121208).

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