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**OPTIMISATION AND CHARACTERISATION OF BIODIESEL FROM
BIODEGRADATION OF ORGANIC WASTES BY BLACK
SOLDIER FLY LARVAE**


ABSTRACT

This research aimed to optimise and characterise environmental friendly biodiesel produced through biodegradation of organic wastes by black soldier fly (*Hermetia illucens*) larvae. This research is divided into four main studies, namely characterisation of organic wastes, cultivation of insect larvae, characterisation of insect larval lipid and determination of the properties of insect larval biodiesel. The organic wastes used for cultivation of insect larvae were food kitchen waste (FKW), soya residue (SR) and mixed waste (MW). The main scientific instruments used in this study were Fourier transform infrared (FTIR) spectrometer, nuclear magnetic resonance (NMR) spectrometer and gas chromatography-flame ionisation detector (GC-FID). For organic wastes and insect larvae characterization, several analyses such as content of moisture, protein, carbohydrate, ash and fat, pH value and crude fiber were carried out. The extraction of larval lipid was conducted using Soxhlet method and underwent a two-step transesterification process to produce biodiesel. The highest yield of biodiesel (95.80%) was from black soldier fly larval lipid as a result of fed by FKW followed by SR (90.26%) and MW (90.25%). FTIR and NMR analyses confirmed the successful transformation of larval lipid to biodiesel by the appearance of the fatty acid methyl ester (FAME) functional groups in the spectra. While, GC-FID analysis showed the FAME composition of biodiesel comprised of both saturated (lauric acid, myristic acid, palmitic acid, capric acid and stearic acid) and unsaturated (oleic acid, palmitoleic acid and linoleic acid) FAME. The produced insect larval biodiesel met the value recommended by American Society for Test and the Materials (ASTM) D6751 and European (EN) 14214 standards. In conclusion, black soldier fly larvae were able to convert organic wastes studied to biodiesel. In implication, the insect larvae can be potentially applied as a low-cost biodiesel feedstock for reducing the operational cost of biodiesel production.


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**PENGOPTIMUMAN DAN PENCIRIAN BIODIESEL DARIPADA
BIODEGRADASI SISA ORGANIK OLEH LARVA
LALAT ASKAR HITAM**


ABSTRAK

Kajian ini bertujuan untuk mengoptimum dan mencirikan biodiesel mesra alam terhasil melalui biodegradasi sisa organik oleh larva lalat askar hitam (*Hermetia illucens*). Penyelidikan ini dibahagikan kepada empat kajian utama, iaitu pencirian sisa organik, pemeliharaan larva serangga, pencirian lipid larva serangga dan penentuan sifat-sifat biodiesel larva serangga. Sisa organik yang digunakan untuk pemeliharaan larva serangga adalah sisa makanan dapur (FKW), hampas soya (SR) dan campuran sisa (MW). Peralatan saintifik utama yang digunakan dalam kajian ini ialah spektrometer inframerah transformasi Fourier (FTIR), spektrometer resonans magnet nukleus (NMR) dan kromatografi gas-pengesan nyala pengionan (GC-FID). Bagi pencirian sisa organik dan larva serangga, beberapa analisis seperti kandungan lembapan, protein, karbohidrat, abu dan lemak, nilai pH dan serat kasar telah dijalankan. Pengekstrakan lipid larva telah dilakukan menggunakan kaedah Soxhlet dan telah menjalani suatu proses transpengesteran dua langkah untuk menghasilkan biodiesel. Hasil biodiesel tertinggi (95.80%) adalah dari lipid larva lalat askar hitam hasil suapan FKW diikuti SR (90.26%) dan MW (90.25%). Analisis FTIR dan NMR mengesahkan kejayaan transformasi lipid larva kepada biodiesel dengan kehadiran kumpulan-kumpulan berfungsi asid lemak metil ester (FAME) di dalam spektra. Manakala, analisis GC-FID telah menunjukkan komposisi FAME biodiesel terdiri dari kedua-dua FAME, tepu (asid laurik, asid miristik, asid palmitik, asid kaprik dan asid stearik) dan tak tepu (asid oleik, asid palmitoleik dan asid linoleik). Biodiesel larva serangga yang dihasilkan menepati nilai yang disyorkan oleh piawai *American Society for Test and the Materials (ASTM) D6751* dan piawai *European (EN) 14214*. Kesimpulannya, larva lalat askar hitam mampu menukar sisa organik yang dikaji kepada biodiesel. Implikasinya, larva serangga berpotensi digunakan sebagai suatu stok suapan biodiesel berkos rendah bagi mengurangkan kos operasi penghasilan biodiesel.


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