UNIVERSITAS GADJAH MADA
COBALT AND MOLYBDENUM DISPERSED ONTO CORNCOB WASTE-DERIVED ACTIVATED CARBON CATALYSTS FOR MICROWAVE-ASSISTED HYDROTREATMENT OF TAMANU OIL (Calophyllum inophyllum) INTO BIO-JET FUEL
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ABSTRACT

Corncob, an abundant agricultural waste that is often discarded without utilization, was valorized in this study as activated carbon (AC) support for bimetallic cobalt–molybdenum catalysts. The catalysts were synthesized via ultrasound-assisted impregnation using three different metal incorporation sequences: cobalt-first impregnation (Co–Mo/AC), molybdenum-first impregnation (Mo–Co/AC), and simultaneous co-impregnation (CoMo/ACThe catalysts were then applied in microwave-assisted hydrotreatment for the production of bio-jet fuel from tamanu oil (*Calophyllum inophyllum*), a locally abundant non-edible feedstock in Indonesia that remains largely underexplored for sustainable aviation fuel applications. Catalyst characterization was performed using XRD, FTIR, NH_3–TPD, N_2 physisorption (SAA), SEM–EDX, and TEM, while the liquid products obtained from hydrotreatment were analyzed by GC–MS and FTIR.

The results confirmed the successful synthesis of mesoporous AC from corncobs. Among the prepared catalysts, Co–Mo/AC exhibited the highest surface area (363.97 $m^2\ g^{-1}$), total pore volume (0.210 $cm^3\ g^{-1}$), and total acidity (0.887 mmol g^{-1}). Tamanu oil was found to be rich in oleic and palmitic acids, making it a promising feedstock for hydrocarbon fuel production. Under optimum reaction conditions (30 min, 600 W microwave power, H_2 flow rate of 20 mL min^{-1}, and catalyst-to-feed ratio of 1:100 w/w), Co–Mo/AC achieved the highest bio-jet fuel yield (55.36 wt%) and selectivity (68.96%), outperforming Mo–Co/AC (44.45 wt% yield and 55.87% selectivity) and CoMo/AC (44.27 wt% yield and 55.49% selectivity). Catalyst reusability was evaluated over four consecutive cycles. Although a gradual decline in performance was observed, Co–Mo/AC maintained bio-jet fuel yields of 55.36 wt%, 39.53 wt%, 36.38 wt%, and 35.89 wt%, with corresponding selectivities of 68.96%, 55.30%, 54.07%, and 53.76% from the first to the fourth cycle. These findings demonstrate that the sequential impregnation strategy significantly influences catalyst properties and catalytic performance, while highlighting the potential of corncob-derived activated carbon-supported Co–Mo catalysts as sustainable and cost-effective materials for renewable bio-jet fuel production.

Keywords: activated carbon, bio-jet fuel, cobalt–molybdenum, microwave-assisted catalysis, tamanu oil

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KATALIS KOBALT DAN MOLIBDENUM TERDISPERSI PADA KARBON AKTIF DARI LIMBAH BONGGOL JAGUNG UNTUK HYDROTREATMENT BERBANTUAN MICROWAVE MINYAK NYAMPLUNG (Calophyllum inophyllum) MENJADI BIOAVTUR

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INTISARI

Bonggol jagung merupakan limbah pertanian yang melimpah, namun pemanfaatannya masih relatif terbatas. Dalam penelitian ini, bonggol jagung dimanfaatkan sebagai sumber karbon aktif (AC) yang digunakan sebagai penyangga katalis bimetalik kobalt–molibdenum. Katalis disintesis melalui metode impregnasi berbantuan ultrasonik dengan tiga variasi urutan pemasukan logam, yaitu impregnasi kobalt terlebih dahulu (Co–Mo/AC), impregnasi molibdenum terlebih dahulu (Mo–Co/AC), dan ko-impregnasi simultan (CoMo/AC). Katalis tersebut kemudian diaplikasikan dalam proses *hydrotreatment* berbantuan *microwave* untuk menghasilkan bio-jet fuel dari minyak nyamplung (*Calophyllum inophyllum*), salah satu sumber minyak non-pangan yang melimpah di Indonesia dan berpotensi dikembangkan sebagai bahan baku bahan bakar penerbangan berkelanjutan. Karakterisasi katalis dilakukan menggunakan XRD, FTIR, NH_3-TPD, fisisorpsi N_2 (SAA), SEM–EDX, dan TEM, sedangkan produk cair hasil *hydrotreatment* dianalisis menggunakan GC–MS dan FTIR.

Hasil penelitian menunjukkan bahwa karbon aktif berhasil disintesis dari bonggol jagung dan berfungsi sebagai pengemban katalis Co–Mo. Di antara seluruh katalis yang disiapkan, Co–Mo/AC memiliki luas permukaan spesifik, volume pori total, dan keasaman tertinggi, masing-masing sebesar 363,97 $m^2\ g^{-1}$, 0,210 $cm^3\ g^{-1}$, dan 0,887 mmol g^{-1}. Minyak nyamplung yang kaya akan asam oleat dan asam palmitat terbukti berpotensi sebagai bahan baku produksi bahan bakar hidrokarbon. Pada kondisi optimum (30 menit, daya gelombang mikro 600 W, laju alir H_2 20 mL $menit^{-1}$, dan rasio katalis terhadap bahan baku 1:100 b/b), katalis Co–Mo/AC menghasilkan rendemen bioavtur tertinggi sebesar 55,36% (b/b) dengan selektivitas 68,96%, lebih tinggi dibandingkan Mo–Co/AC dan CoMo/AC. Uji penggunaan ulang selama empat siklus menunjukkan adanya penurunan kinerja secara bertahap, namun Co–Mo/AC mampu mempertahankan rendemen bioavtur sebesar 35,89% (b/b) dan selektivitas 53,76% pada siklus keempat. Hasil ini menunjukkan bahwa urutan impregnasi logam berpengaruh terhadap sifat fisikokimia dan aktivitas katalitik katalis, serta menegaskan potensi karbon aktif berbasis bonggol jagung sebagai material penyangga yang berkelanjutan dan ekonomis untuk produksi bioavtur terbarukan.

Kata kunci: bioavtur, karbon aktif, katalisis berbantuan gelombang mikro, kobalt–molibdenum, minyak nyamplung.