

Antioxidant and Antibacterial Activities of Leave Extracts of *Cordyline fruticosa* Back

Christian Kurnia Putra^{1,2*}, Oraphin Chantarasriwong¹, Harlinda Kuspradini², Irawan Wijaya Kusuma² and Choladda Srisuwannaket^{1*}

¹Organic Synthesis and Natural Product Research Unit, Department of Chemistry, Faculty of Science, King Mongkut's University of Technology Thonburi, 126 PrachaUthit Rd., Bang Mod, ThungKhru, Bangkok, 10140, Thailand

²Forest Product Chemistry Laboratory, Faculty of Forestry, Mulawarman University, Gunung Kelua Campus, PO BOX 1068, Samarinda, East Kalimantan, 75119, Indonesia

*E-mail: christian.kputra@mail.kmutt.ac.th, choladda.sri@kmutt.ac.th

Cordyline fruticosa Back is traditionally used for treatment of various diseases in Indonesia. The leaves of *C. fruticosa* Back were collected from East Kalimantan Province, Indonesia, and extracted by different polarity solvents: methanol (MeOH), ethyl acetate (EtOAc) and hexane to determine their antioxidant and antibacterial activities. The DPPH radical scavenging assay identified that all extracts had potent antioxidant activity (IC₅₀ 0.94-8.19 mg/mL) with the EtOAc extract showing the highest antioxidant activity. All extracts also presented the potent antioxidant activity in the Fe²⁺ chelating assay (IC₅₀ 0.91-3.86 mg/mL) with the highest activity found in hexane extract. In the FRAP assay, the EtOAc extract exhibited the strongest ferric reducing power activity (31.36 ± 0.21 mmol Fe²⁺ equivalents (eq)/1 g sample) followed by MeOH extract (15.83 ± 1.96 mmol Fe²⁺ eq/g) and hexane extract (9.58 ± 0.38 mmol Fe²⁺ eq/g). In the Folin-Ciocalteu assay, the MeOH extract showed the highest total phenolic content value (41.91 ± 1.32 mg gallic acid equivalent (GAE)/1 g sample) followed by hexane extract (24.62 ± 0.84 mg GAE/g) and EtOAc extract (23.16 ± 0.94 mg GAE/g). In addition, the MeOH extract displayed antibacterial activity against *Bacillus cereus*, *Salmonella thypii* and *Streptococcus sobrinus* with a diameter of inhibition zone of 9.11, 8.15 and 8.09mm, respectively at a concentration of 500 ppm. These results indicate that *C. fruticosa* Back is potentially used for natural antioxidant and antibacterial agents.

Keywords *Cordyline fruticosa*; Antioxidant activity; Antibacterial activity

Selective Hydrogenation of *trans*-2-Hexenal to 2-Hexenol over Cobalt-Based Catalysts

Natthida Numwong, Khanokthip Yathongchai, Kittichai Rujipornsakul, Nuttapoom Ruttanajairakul and Tawan Sooknoi*

*Catalytic Chemistry Research Unit, Department of Chemistry, Faculty of Science,
King Mongkut's Institute of Technology Ladkrabang, Chalongkrung Rd., Ladkrabang, Bangkok 10520,
Thailand*

*E-mail: kstawan@kmitl.ac.th

Selective hydrogenation of unsaturated aldehydes to corresponding unsaturated alcohols has an industrial significance in the production of fine chemicals. However, this reaction is difficult because C=C bond is more reactive than C=O bond for hydrogenation over typical noble metal catalyst. In this work, selective hydrogenation of *trans*-2-hexenal to 2-hexenol was carried out in a continuous fixed bed down-flow reactor at 80°C. In order to improve the selectivity towards 2-hexenol, the addition of second element: Cu, Fe, and Pt, to silica supported cobalt catalysts (M-Co/SiO₂, M= Cu, Fe and Pt) were investigated. These catalysts were prepared by sequential impregnation technique and characterized by X-ray diffraction (XRD), surface area analysis, temperature program reduction (TPR), and temperature program desorption of CO₂ (CO₂-TPD). It was found that the pathway of this reaction is starting from the hydrogenation of 2-hexenal to 2-hexenol and hexanal followed by hydrogenation to hexanol. Moreover, hexanal can be further converted to high molecular weight aldol compound over basic site of the cobalt-based catalysts. The PtCo/SiO₂ catalyst exhibits the highest hydrogenation activity and selectivity towards 2-hexenol products (38.3% and 28.1%, respectively at 73 g.h/mol contact time). In contrast, the FeCo/SiO₂ and CuCo/SiO₂ catalysts show low activity for hydrogenation and high promotion to undesirable aldol products.

Keywords Selective hydrogenation; *Trans*-2-hexenal; Co/SiO₂ Catalyst

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Influence of Fe Loading Method on Zeolite MCM-22 on the Catalytic Performance in Phenol Hydroxylation

Onsulang Sophonphun¹, Sirinuch Loiha², Arthit Neramittagapong³, Karin Föttinger⁴, Sanchai Prayoonpokarach¹, Jatuporn Wittayakun^{1*}

¹Material research group, School of Chemistry, Institute of Science, Suranaree University of Technology, NakhonRatchasima 30000, Thailand

²Department of Chemistry, Faculty of Science³Department of Chemical Engineering, faculty of Engineering, KhonKaen University, KhonKaen 4002, Thailand

⁴Institute of Materials Chemistry, Vienna University of Technology, Vienna 1060, Austria
*E-mail: jatuporn@sut.ac.th

[Al,Si]-MCM-22 was synthesized by hydrothermal method under stirring. Fe was loaded on [Al,Si]-MCM-22 through incipient wetness impregnation (IWI), liquid state ion-exchange (LSIE) and solid state ion-exchange (SSIE). From characterization by X-ray diffraction, all Fe loading methods did not destroy the structure of MCM-22. From N₂ adsorption-desorption analysis, a decrease in surface area of MCM-22 after Fe loading by IWI, LSIE and SSIE was less than 10%. The Fe loading on the catalysts was confirmed by an inductive couple plasma optical emission spectroscopy (ICP-OES). Loading from IWI and SSIE were 6% but from LSIE was around 1%. From X-ray absorption near edge structure, all supported Fe catalysts were in Fe₂O₃ phase. From Diffused reflectance UV-vis spectra, all supported Fe catalysts showed peaks assigned to Fe (III) species inside the cavities of MCM-22. Beside the catalysts from IWI and SSIE obviously showed broad bands assigned to hematite particle on the external surface of MCM-22. The prepared catalysts were tested for phenol hydroxylation in a batch reactor at 70 °C with phenol: H₂O₂ molar ratio of 1:1. The progress of the reaction was investigated by gas chromatography with flame ionization detector. The phenol conversion reached 55% in 0.5 h. The observed products were benzoquinone (BQ), catechol (CAT) and hydroquinone (HQ). The catalyst from LSIE was the most active one giving 54% phenol conversion, 46% CAT selectivity, 28% HQ selectivity and 26% of other products within 15 min. Carbon mass balance during the reaction indicated that the other products were from catalyst deactivation which increased in the order of LSIE < SSIE < IWI. Such trend was in a good agreement with results from temperature program oxidation.

Keywords [Al,Si]-MCM-22; Incipient wetness impregnation; Liquid state ion-exchange; Solid state ion-exchange; Phenol hydroxylation

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Comparison of PdCo/SBA-15 Prepared by Co-impregnation and Sequential-impregnation for Fischer-Tropsch Synthesis

Nattawut Osakoo^{1,2}, Robert Henkel², Sirinuch Loiha³, Frank Roessner², Jatuporn Wittayakun^{1*}

¹*School of Chemistry, Institute of Science, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand*

²*Technische Chemie II, Carl von Ossietzky Universität Oldenburg, Oldenburg D-26111, Germany*

³*Department of Chemistry, Faculty of Science, KhonKaen University, KhonKaen 40002, Thailand*

*E-mail: jatuporn@sut.ac.th

Fischer-Tropsch Synthesis (FTS) is a reaction of CO and H₂ to produce fuels. The most superior catalyst for FTS is cobalt (Co) which gives high selectivity for C₅₊ products. Its catalytic performance could be enhanced by dispersion on a support with uniform pores and high surface area, particularly, SBA-15 which has uniform hexagonal channels and high thermal stability. To increase reducibility of cobalt oxides, Pd was added as a promoter. Recently, we studied properties of bimetallic catalyst 0.2Pd-10Co/SBA-15 consisting of 10 wt% of Co and 0.2 wt% of Pd on SBA-15 and SBA-15(M). From catalytic testing in FTS, 0.2Pd-10Co/SBA-15 gave the highest selectivity (31.5%) for products in gasoline range (C₅-C₉) but it had the largest particle size of cobalt oxides and had lower conversions of CO (35.6%) than other catalysts. To improve the activity and selectivity (C₅-C₉) in FTS, properties and catalytic performance of bimetallic Pd-Co/SBA-15 prepared by co-impregnation (0.2Pd-10Co-CIP) and sequential impregnation (0.2Pd-10Co-SIP) for (FTS) were investigated. The particle size of cobalt oxides in 0.2Pd-10Co-SIP were smaller than those in 0.2Pd-10Co-CIP leading to less decrease in pore size and surface area of SBA-15 as well as higher reduction temperature. These evidences could be confirmed by several characterization techniques including X-ray diffraction (XRD), X-ray absorption (XAS), N₂ adsorption-desorption and H₂-temperature programmed reduction (H₂-TPR). From FTS testing higher conversions of CO (56.5%) and yield of C₅-C₉ products (18.6 %) were obtained from 0.2Pd-10Co-SIP.

Keywords Fischer-Tropsch Synthesis; Cobalt, Palladium; SBA-15; Co-impregnation; Sequential impregnation

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Clear and Stable Low Tension Water Flood for a High Temperature Formation Having High Salinity and Hardness: A Case Study (Lekhwaier Reservoir)

S. AL-Faraji¹, R. S. Al-Maameri², M. Aoudia¹

¹Sultan Qaboos University, College of Science PO. Box 36 Al-Khoudh 123, Muscat Sultanate Oman
²Sultan Qaboos University, College of Engineering, PO. Box 33 Al-Khoudh 123, Musca Sultanate Oman

m009450@student.squ.edu.om

In this work, we investigated the effect of temperature on the compatibility of three 30% active alkyl ether sulfonate (AES1: $nC_{17}-(O-CH_2CH_2)_7-SO_3Na$), (AES2: $iC_{17}-(O-CH_2CH_2)_{10}-SO_3Na$) and (AES3: $nC_{17}-(O-CH_2CH_2)_{10}-SO_3Na$) surfactants with a petroleum formation brine having high salinity and hardness (total salinity: 181 g/L, Ca^{2+} : 10.3 g/L, and Mg^{2+} : 4.0 g/L), typical reservoir conditions prevailing in challenging Omani oil fields. The degree of sulfonation is 85%, (0.85 wt% AES/0.15 wt% AE). These type of surfactants are widely used in enhancing oil recovery due to their stability at high T and tolerance to electrolyte.¹⁻³ AES1 was found to form turbid solutions at room temperature (23 °C) in the concentration range 0.025-1.0 wt%, which ultimately separate into two phases, a gel-like suspension and a clear lower phase. Upon heating, these solutions remain turbid. On the other hand, AES2 formed clear and stable solutions in brine at room temperature. Concentration dependent clear-to-turbid transition temperatures were observed upon heating. AES3 formed turbid solutions at room temperature but they turn clear while heating and by further heating they became turbid again. These observations indicate that AES surfactants exhibit both clear point (anionic property) and cloud (nonionic property). This is a significant finding when using these AES surfactants for EOR formulations. Enhancement of AES-brine compatibility was achieved by mixing AES surfactants with nonionic polyoxyethylene (AE) surfactants as reflected by the increase in the cloud point of the surfactant mixed system. Thus, potential clear and stable surfactant mixtures for EOR applications in high salinity and hardness were generated in a wide range of temperature (~ 23-85 °C).