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Biodegradation of chlorinated contaminants by Balok River sediment and characterization of its end metabolite

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ABSTRACT

Chlorinated contaminants are toxic organic contaminants that was commonly detected in the ground water source in Malaysia. Anaerobic biodegradation is one of the alternative techniques to assist in the breakdown of chlorinated contaminants into less toxic and biodegradable materials. The present study aimed to investigate the ability of Balok River sediment as biomaterial to anaerobically degrade chlorinated contaminants and to characterize the functional groups present before and after the degradation. Complete removal for 1,2-dichloroethane (1,2-DCA), 1,2-dichloropropane (1,2-DCP), chloroform (CF) and perchloroethylene (PCE) by the sediment was observed after several days. The Fourier Transform Infrared (FT-IR) demonstrated the absence of chloride ion and formation of alkene functional groups after the 1,2-DCA biodegradation, implying that the degradation is via dichloroelimination mechanism. This study suggests that chlorinated contaminants can be successfully removed by incorporating Balok River sediment as the biomaterial.

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1. Introduction

Chlorinated aliphatic hydrocarbons (CAHs) are the common compound that has been discovered in the soil and groundwater. This compound can cause several health problems resulting from its toxicity, bioaccumulation and persistence [1]. In a study conducted by the National Hydraulic Research Institute of Malaysia (NAHRIM) on groundwater contamination in Malaysia, chloride was among the most encountered contaminants in groundwater located at Kelantan, Pahang, Selangor and Negeri Sembilan [2]. Furthermore, several chlorinated and brominated compounds such as chloroform, cis and *trans*-1,2-dichloroethylene, trichloroethylene, 1,2-dibromoethane, chlorobenzene, 1,4- dichlorobenzene and 1,2-dichlorobenzene were detected in drinking water of Peninsular Malaysia [3].

The common treatment of chlorinated hydrocarbons is based on physical, chemical and aerobic biodegradation treatment methods. This chlorinated aliphatic compound is usually removed by gas separation and adsorption [4]. However, this processing method is expensive and produces undesirable by-products [5]. Meanwhile, for aerobic biodegradation treatment, there is some limitation for the presence of oxygen conditions which is hard to be maintained especially in saturated subsurface systems [6]. In addition, the aerobic process is slower and prone to oxidative stress [7]. Thus, anaerobic biodegradation has become an alternative method to assist in the decomposition of pollutant materials in simpler forms and less toxic components [8]. Biological transformation of halogenated compounds under anaerobic conditions has not been studied in detail in Malaysia despite they are frequently detected in contaminated soils and groundwater. To the best of our knowledge, no anaerobic bacteria capable of degrading organohalides has been isolated from Malaysia's local sources.

Organohalide-respiring Bacteria (OHRB) are anaerobic microorganisms that are capable of deriving energy for their growth from the dehalogenation of aliphatic and aromatic halogenated compounds [9]. These bacteria can reduce halogenated compounds which are significant contaminants in groundwater systems that pose a hazard to human health and the environment [10]. The OHRB utilize metabolic dehalogenation by organohalide respiration to acquire energy for their growth [9]. Organohalide respiration is an energy-conserving respiratory process where a halogen-carbon bond is broken and the halogen atom is liberated as a halide [11]. Eventhough various numbers of OHRB have been

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