

# Evaluation of distribution and sources of sewage molecular marker (LABs) in selected rivers and estuaries of Peninsular Malaysia

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**Abstract** This is the first extensive report on linear alkylbenzenes (LABs) as sewage molecular markers in surface sediments collected from the Perlis, Kedah, Merbok, Prai, and Perak Rivers and Estuaries in the west of Peninsular Malaysia. Sediment samples were extracted, fractionated, and analyzed using gas chromatography mass spectrometry (GC-MS). The concentrations of total LABs ranged from 68 to 154 (Perlis River), 103 to 314 (Kedah River), 242 to 1062 (Merbok River), 1985 to 2910 (Prai River), and 217 to 329 ng g<sup>-1</sup> (Perak River) dry weight (dw). The highest levels of LABs were found at PI3 (Prai Estuary) due to the rapid industrialization and population growth in this region, while the lowest concentrations of LABs were found at PS1 (upstream of Perlis River). The LABs ratio of internal to external isomers (I/E) in this study ranged from 0.56 at KH1 (upstream of Kedah River) to 1.35 at MK3 (Merbok Estuary) indicating that the rivers receive raw sewage and primary treatment effluents in the study area. In general, the results of this paper

highlighted the necessity of continuation of water treatment system improvement in Malaysia.

**Keywords** Linear alkylbenzenes (LABs) · I/E ratio · Perlis River · Merbok River · Prai River · Malaysia

## Introduction

Pockets of Malaysian aquatic environments, especially raw surface water, become contaminated as a result of excessive and indiscriminate discharge of wastewater directly from households or factories to drains and into rivers with minimal or no treatment. Organic contaminants such as LABs are introduced into aquatic environments from untreated domestic wastewater and industrial effluents (Islam and Tanaka 2004; Oller et al. 2011).

LABs with a C<sub>10</sub>–C<sub>14</sub> normal alkyl chain are the raw materials for linear alkylbenzenesulfonate (LAS) production. LASs are synthesized by sulfonation of LABs with H<sub>2</sub>SO<sub>4</sub> or SO<sub>3</sub> (Ricking et al. 2003). As a result of this incomplete sulfonation, LABs have been discharged into the environment as a by-product of LAS detergents. They are constituents which are found everywhere in many aquatic environment such as treated and untreated domestic wastewater in river water and sediments (Takada and Ishiwatari 1987; Wei et al. 2014; Dauner et al. 2015).

LABs are minor constituents in commercial LAS detergents and more stable markers than LAS. Moreover, LABs have been proposed as molecular markers of wastewater because of their widespread occurrence in the aquatic environment (Ishiwatari et al. 1983; Takada and Ishiwatari 1987; Hartmann et al. 2000). Once LABs are introduced into the

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