SPATIAL DISTRIBUTION OF POLYCYCLIC AROMATIC HYDROCARBONS IN MANGROVE SEDIMENT AND ROOT IN REMBAU-LINGGI ESTUARY

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1.0 Introduction

Southeast Asia's mangroves are known internationally as being the world's largest and best-developed; along with a total of 42 plant species have been recorded in Malaysian mangrove vegetation (Giesen et al., 2007). Covering the muddy shores of sheltered coasts and river estuaries, mangrove is a continuous belt of the forest area facing the Straits of Malacca which plays important roles such as flood control, sediment control, coastal erosion prevention and natural barriers against tsunamis and storms. Recently, mangrove swamps in Malaysia are facing threat of the accumulation of pollutants due to the increasing of industrialization and urbanization. About 20 percent of the total mangrove area has been lost in last two decades with the most significant losses have been in Peninsular Malaysia, where large areas have been converted for agriculture, coastal road development as well as housing estates (Giesen et al., 2007). Anthropogenic activities derived from industrialization and urbanization such as fossil fuel combustion, discharge of domestic sewage and incineration of industrial give a great contribution of pollution generating especially in marine and coastal environment. Abdullah et al. (1999) has discussed the identification of land and sea-based sources of pollution in Malaysia which contribute to pollution load in the Straits of Malacca. One of the major threats is petroleum pollution which is sea-based pollutant. Anthropogenic activities in marine environment such as oil spill might harm and affect the mangrove ecosystems due to transportation of particulate matter that partition with the PAHs and other hydrophobic organic contaminants to the mangrove sediments.

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of two or more fused aromatic rings which are one of the most widespread organic pollutants. United States Environmental Protection Agency (USEPA) has identified sixteen individual PAH compounds as priority pollutants due to their mutagenic and carcinogenic characteristics (Varanasi, 1989). Because of their low water solubility and hydrophobic nature, PAHs mix more easily with oil than water. Due to these properties, PAHs in the environment are found mostly in sediment, soil, and oily substances. PAHs entering the marine environment are tending to absorb onto particulates, and finally accumulate in the sediment for long period of time because PAHs are persistent organic pollutants. There are two classes of PAHs: low molecular weight PAHs with two or three benzene rings from naphthalene to anthracene and high molecular weight PAHs with four to six rings from flouranthene to indeno(1,2,3,-*cd*)pyrene. These classes can be distinguished based on their properties and molecular weight. Low molecular weight (LMW) PAHs results in acute toxicity while high molecular weight (HMW) PAHs results in chronic toxicity and may be carcinogenic and mutagenic.

2.0 Research Objectives

1. To determine the distribution of PAHs in mangrove sediment and pneumatophore root in Rembau-Linggi estuary
2. To determine the correlation of PAHs concentration between mangrove sediment and pneumatophore root

3.0 Research Methodology

3.1. Study area

Mangrove swamp in Rembau-Linggi estuary

3.2. Sampling Procedure

Three replicate samples of mangrove surface sediment (0-5cm) and pneumatophores root were randomly collected from eight sampling stations using Hand Auger during low tide. The samples were transferred into zip-lock plastic bag and placed on ice in a cooler until they were returned to the laboratory where they were stored at $4^{o}C$ in an ice box prior to further analysis. All material in contact with the sample previously washed with deionized water, acetone and methanol in order to prevent cross-contamination.

3.3. Samples Analysis Procedure

3.3.1. PAHs Analysis

The sediment and root samples will be weighed between 15-20 g. The samples will be extracted with a soxhlet extractor using dichloromethane (DCM) for more than 8 hours. Whatman cellulose thimber will be used for this purpose. After the soxhlet extraction, the samples will be concentrated to near dryness and a few of copper chip will be added into the samples. The solution will be purified and fractionated. 50 µl of the surrogate internal standard mixture (SIS) are added to the samples extracts. The solution is transfer onto the top of 5% H_2O deactivated silica gel column. The flask with reduced sample is rinse with 2 ml Hexane: DCM (3:1 v/v). In the second step column chromatography, 100% fully activated silica gel will be used to pack the column. PAHs will be analyzed by gas chromatograph – mass spectrometer (GC-MS) (Zakaria et al., 2000; Zakaria and Mahat, 2006).

3.3.1. Total Organic Carbon (TOC) Analysis

The sediment samples were dried overnight at 60°C in oven, and then thoroughly ground to a fine powder and homogenized using mortar and pestle. Acidification procedure was used in order to eliminate inorganic carbon (carbonates) that contain in the samples. 1-2 g of each sample was weighed and 1-2 ml of 1M HCL was added drop by drop until the sample completely moist with HCl. The samples were dried at 100°C for ten hours to remove hydrochloric acid. 1 g of each sample was reweighed and then analyzed using LECO CR-412 Carbon Analyzer at 1350°C to determine TOC percentage (Nelson and Sommers (1996); Nieuwenhuize et al., 1994).

4.0 Result & Discussion

Organic carbon had a great influence on distribution and contribution of PAHs in the sediment, where carbon content is an important controlling factor of the sorption of PAHs on sediment (Karickhoff et. al., 1979; Gustafsson et. al. 1997). Total PAHs concentrations will be normalized to organic carbon contents in order to eliminate the grain size effect of the sediment (Bakhtiari et al. 2009). Several studies demonstrated that the sorption of hydrocarbons is highly related to organic matter of the sediments (Karickoff, 1981; Boehm and Farrington, 1984; Fengetal., 1998). Previous study also found significant positive correlations between total organic carbon & PAHs in sediment (Bakhtiari et al., 2009; Barra et al., 2009; Punning et al., 2008; Liang et al., 2007; Zhang et al., 2006; Zhang et al., 2004; Tolosa et al., 2004; Thorsen et al., 2004; Kim et al., 1999). The properties of the sediment such as organic carbon would influence the distribution and concentration of PAHs and other hydrophobic organic compounds (Kim et al., 1999).

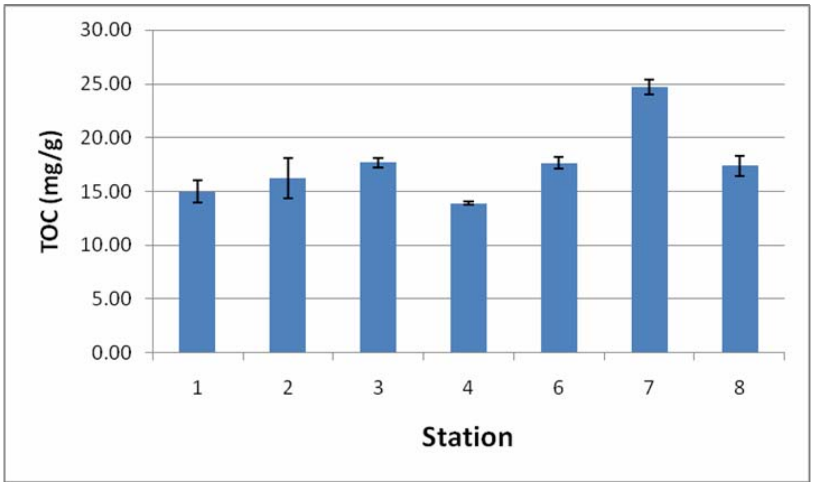

Fig. 1. Concentration of total organic carbon in mangrove sediment

Figure 1 show the total organic carbon (TOC) concentration in mangrove sediment for seven stations in Rembau-Linggi estuary. Results suggested that a high TOC concentration occurred in the station 7 which located downstream of the Linggi river. On the other hand, the lowest TOC concentration was recorded in the station 4 which located in the confluence of the Linggi river and Rembau river. This could be a result of different land uses in the estuary area. There is a lot of Rhizophora species with stilt root live along with the Sonneratia Alba species in the station 7. There are also aquacultures cages of Tilapia and Siakap located about 400m from the station 7, and Kuala Linggi Bridge located about 300m from the station 7 where a lot of people everyday using the bridge as a place for the fishing activities.

5.0 Significance of finding

Mangrove sediment with unique characteristics such as rich organic carbon and anoxic conditions, make them a preferential site for deposition and accumulation of polycyclic aromatic hydrocarbons (PAHs) in mangrove sediments. Carbon content is an important controlling factor of the sorption of PAHs on sediment hence affects the distribution of PAHs in the estuary.