



Aliphatic hydrocarbons and triterpane biomarkers in mangrove oyster (*Crassostrea belcheri*) from the west coast of Peninsular Malaysia



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ABSTRACT

The Straits of Malacca is one of the world's busiest shipping routes where frequent oil spills occur. Rapid development in the west coast of Peninsular Malaysia is the other major source of petroleum pollution in this narrow waterway. In order to identify occurrence and origin of hydrocarbons in the Straits, mangrove oysters (*Crassostrea belcheri*) were collected from five sampling locations and analysed for *n*-alkanes and biomarkers. Soxhlet apparatus and two step column chromatography were used for extraction, purification and fractionation of the oysters. Petroleum origin *n*-alkanes were detected in majority of the sampling locations which is indicative of anthropogenic activities in this region. Using source and maturity diagnostic ratios for hopanes revealed used crankcase oil as the main source of petroleum hydrocarbons in oysters from all sampling locations except for the Pulau Merambong where signature of South East Asia crude oil (SEACO) was detected.

1. Introduction

Petroleum pollution has been a prominent problem since commercial drilling of oil in the late 19th century. Pollutants derived from petroleum and its products seem to be increasing in the future. In industrialized and urbanized areas with intense anthropogenic activities, petroleum pollution is more significant. Peninsular Malaysia's intense industrialization and urbanization in recent decades has led to high consumption of petroleum and its products. The western coast of Peninsular Malaysia has experienced higher levels of development than that of the eastern seaboard of the country. Moreover, the west coast lies directly to the Straits of Malacca which is a narrow waterway with intense oil tanker traffic. The Straits of Malacca is the shortest shipping route for transportation of oil tankers from Middle East and North Europe to Northeast Asian countries such as Japan, Korea and China. Furthermore, a huge number of merchant ships pass through the Straits turning it into one of the busiest shipping routes in the world. As a result, large and small accidental oil spills as well as spillage from ballast water and tanker washing discharges occur frequently (Thia-Eng et al., 2000). Consequently, the west coast of Peninsular Malaysia receives pollutants including those from petroleum and its products from both land and sea.

n-Alkanes are saturated hydrocarbons with C_nH_{2n+2} chemical formula consisting of hydrogen and carbon with the utmost number of bonds. *n*-Alkanes mainly have petroleum origin in the environment,

however, natural sources also contribute to the occurrence of *n*-alkanes. The cuticle of land plants is covered by epicuticular wax which contains high amounts of high molecular weight (HMW) *n*-alkanes predominated by odd carbon atoms. However, short chain *n*-alkanes predominated by odd carbon atoms, especially C_{17} have cyanobacteria and alga origins (Eglinton and Eglinton, 2008). Moreover, odd numbered mid-chain *n*-alkanes including C_{21} , C_{23} and C_{25} are abundant in submerged and emersed vegetation (Ficken et al., 2000). Predominance of even carbon atom *n*-alkanes in the environment can signify petrogenic inputs from different anthropogenic activities (Sakari et al., 2008). Terrigenous/aquatic ratio (TAR) which is the ratio of $(C_{27} + C_{29} + C_{31})$ over $(C_{17} + C_{19} + C_{21})$ can demonstrate alternation in marine based and land based natural sources of *n*-alkanes. Average chain length (ACL) is indicative of the average number of carbon atoms in *n*-alkanes originating from land plant in a specific geographical area (Jeng, 2006). Different kinds of plants have different chain length of carbon atoms. Generally, chain length of carbon atoms generated by warm climate plants is longer (Poynter et al., 1989). The ACL values might decrease in the presence of petrogenic inputs. Carbon preference index (CPI) is used as a tool to describe the predominance of long chain *n*-alkanes with odd number carbon atoms over even number carbon atoms in a definite range of carbon chain. CPI draws a comparison between biogenic and petrogenic inputs. CPI of 5 to 10 is indicative of hydrocarbons coming from land plants which contain high loads of *n*-alkanes with 27, 29, and 31 carbon atoms (Rielley et al., 1991) while CPI of about 1 is a sign of petroleum as

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