Marine Pollution Bulletin 100 (2015) 311–320

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Forensic investigation of aliphatic hydrocarbons in the sediments from selected mangrove ecosystems in the west coast of Peninsular Malaysia

Vahab Vaezzadeh [a], Mohamad Pauzi Zakaria [b,*], Aileen Tan Shau-Hwai [c], Zelina Zaiton Ibrahim [d], Shuhaimi Mustafa [e], Fatemeh Abootalebi-Jahromi [a], Najat Masood [a], Sami Mohsen Magam [a], Sadeq Abdullah Abdo Alkhadher [a]

[a] Environmental Forensics Laboratory, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[b] Bachok Marine Research Station, Institute of Ocean and Earth Sciences (IOES), University of Malaya, 16310 Bachok, Kelantan, Malaysia
[c] School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia
[d] Department of Environmental Management, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[e] Halal Products Research Institute, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ARTICLE INFO

Article history:
Received 26 April 2015
Received in revised form 11 August 2015
Accepted 16 August 2015
Available online 29 August 2015

Keywords:
n-Alkanes
Sediment
Aliphatic hydrocarbon
Peninsular Malaysia
Petrogenic
CPI

ABSTRACT

Peninsular Malaysia has gone through fast development during recent decades resulting in the release of large amounts of petroleum and its products into the environment. Aliphatic hydrocarbons are one of the major components of petroleum. Surface sediment samples were collected from five rivers along the west coast of Peninsular Malaysia and analyzed for aliphatic hydrocarbons. The total concentrations of C_{10} to C_{36} n-alkanes ranged from 27,945 to 254,463 $ng \cdot g^{-1}$ dry weight (dw). Evaluation of various n-alkane indices such as carbon preference index (CPI; 0.35 to 3.10) and average chain length (ACL; 26.74 to 29.23) of C_{25} to C_{33} n-alkanes indicated a predominance of petrogenic source n-alkanes in the lower parts of the Rivers, while biogenic origin n-alkanes from vascular plants are more predominant in the upper parts, especially in less polluted areas. Petrogenic sources of n-alkanes are predominantly heavy and degraded oil versus fresh oil inputs.

1. Introduction

Petroleum pollution has long been of great concern since there are components in petroleum which have mutagenic and carcinogenic impacts on organisms. The global increasing demand for fuel besides accidental oil spills are two major contributors to the release of petroleum into the environment (Singh et al., 2012). Petroleum hydrocarbons are comprised of a wide variety of chemicals with different origins (Zaghden et al., 2005). Aliphatic hydrocarbons within the range of 1 to 40 carbon atoms are among the compounds commonly found in petroleum (Sackett, 1985). The proportion of aliphatic hydrocarbons including normal alkanes (n-alkanes) can be as high as 35% of petroleum compounds. n-Alkanes are persistent, widespread compounds which occur in aquatic environment from natural and anthropogenic sources. The composition of n-alkanes in the sediment can be applied as a useful tool to identify sources of organic matter as these hydrophobic compounds tend to settle on the sediment (Maioli et al., 2012). n-Alkanes with odd number of carbon atoms are abundant in natural sources. Higher molecular weight n-alkanes within the range of C_{27} to C_{35} with predominance of odd carbon atoms maximizing at C_{29} are indicators of higher plant wax (Eglinton and Eglinton, 2008; Wang et al., 2010), while lower molecular weight ones within the range of C_{15} to C_{19}, especially C_{17} have algae and cyanobacteria origins (Meyers, 2003). Moreover, odd numbered mid-chain n-alkanes including C_{21}, C_{23} and C_{25} are abundant in submerged and emersed vegetation (McKirdy et al., 2010; Seki et al., 2010). n-Alkanes with petrogenic provenance generated through high temperature processes, are depleted in odd carbon atoms dominating with C_{15} to C_{25} n-alkanes (Amijaya et al., 2006; Petersen et al., 2007). Furthermore, long chain n-alkanes with predominance of even number of carbon atoms can be a sign of petrogenic inputs from heavy or degraded oil in the environment (Sakari et al., 2008a). Terrigenous/aquatic ratio (TAR) which is the ratio of $(C_{27} + C_{29} + C_{31})$ over $(C_{17} + C_{19} + C_{21})$ can be used to differentiate between land based and marine based biogenic n-alkanes (Silliman et al., 1996). Generally, terrigenous origin n-alkanes are dominant over marine biogenic n-alkanes in the sediment due to rapid biodegradation of marine biogenic n-alkanes and less hydrocarbon quantity of marine biogenic sources (Singh et al., 2012). Average chain length (ACL) of n-alkanes is another indicator of hydrocarbon sources and shows average number of carbon atoms for n-alkanes having vascular plant origin (Boot et al., 2006). ACL values are constant in locations

* Corresponding author.
E-mail address: mpauzi57@um.edu.my (M.P. Zakaria).

http://dx.doi.org/10.1016/j.marpolbul.2015.08.034