ABSTRACT

Metals are one of the hazardous contaminants in the environment. Santubong Wetland is located near a fishing village and human activities such as industrial, tourism, and fishing activities, thus it may receive various types of wastes from these activities. However, the status of the contamination level of metals in Santubong Wetland was unknown. Hence, this study was carried out to examine the concentrations of aluminium (Al), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni) and lead (Pb) in water and sediment during the wet and dry season, to investigate the concentration of non-essential metals (Cd and Pb) in fishes and to estimate the potential human health risk through the consumption of the fishes from Santubong Wetland. Three stations namely Buntal, Penambir and Demak were chosen in this study and the samplings were carried out once in each seasons; wet season (April 2017) and dry season (July 2017). Physicochemical water quality parameters were taken at each station. The water samples were collected using Van Dorn Water Sampler, the sediment samples were collected using Grab sampler and the fishes were caught using a three-layered gillnet. The water and sediment samples were analysed for Total Organic Carbon (TOC). The sediment samples were further analysed for Total Organic Matter (TOM) and Particle Size Analysis (PSA). The ecological risk was assessed using the ecological risk indices Geo-accumulation Index (Igeo), Potential Contamination Index (PCI) and Enrichment Factor (EF). Prior to metals analysis, the water samples were filtered and acidified while the sediment samples were digested. The fishes caught were identified and the muscle parts of the fishes were digested. All the digested samples were analysed using the Flame Atomic Absorption Spectrophotometer (FAAS). The Bioaccumulation Factor (BAF) in fishes was determined and the human health risk assessment was examined by using Provisional Tolerance Weekly Intake (PTWI), Health Risk Index (HRI), Hazard Index (HI) and safety

limits based on a survey using questionnaires conducted in the wetland. Frequency of Food Occurrence was conducted to examine the feeding habit of the fishes. The concentrations of metals in the water and sediment were found to be spatially different and also varied seasonally due to the rainfall. The metal concentrations in the water ranged between 0.07-5.16 mg/L, 0.02-0.03 mg/L, 0.004-0.02 mg/L, BDL-0.004 mg/L, 0.01-0.04 mg/L and 0.004-0.01 mg/L for Al, Cd, Cr, Cu, Ni and Pb respectively. The metal concentrations in the water were within the range of MMWQCS and NWQS except for Al. The metal concentrations in the sediment ranged between 1918.94-3421.77 mg/kg, 0.06-0.09 mg/kg, 6.85-16.52 mg/kg, 2.45-6.81 mg/kg, 2.84-6.20 mg/kg and 4.56-11.22 mg/kg for Al, Cd, Cr, Cu, Ni and Pb respectively. The sediment was in low to moderate contamination of metals. A total of 28 fish species were examined and the concentration of Cd was ranged between 0.13-1.57 mg/kg while the concentration of Pb was ranged between 0.38-7.44 mg/kg. The metals concentration in the fishes was also found to be related to the feeding habit. The BAF analysis showed that the Pb was accumulated higher than Cd. The concentration of Cd and Pb in *Arius maculatus* and *Nibea soldado* were found to be varied seasonally and spatially. Some fish species exceeded the recommended PTWI and safety limits by FAO/WHO (2004) and MFA (1983) for Cd and Pb. The HRI and HI values in some fish species were also exceeding 1. This suggests that regular consumption of the fishes in this area in large quantities for a long period might impose a bad effect on human health. Thus, the anthropogenic inputs from the human activities carried out in this wetland might have contributed to the concentration of metals in the water, sediment and fishes of this study. The information of this study will be useful for the effective management of this wetland so it can be protected from further deterioration.

Keyword: Metals, water, sediment, fish, wetland

Penilaian Logam dalam Air, Tanah dan Ikan di Tanah Bencah Santubong

ABSTRAK

Logam adalah salah satu bahan pencemar berbahaya kepada alam sekitar. Santubong terletak berdekatan dengan perkampungan nelayan dan kegiatan seperti perindustrian, pelancongan dan perikanan maka kawasan ini berkemungkinan menerima banyak sisa buangan dari kegiatan-kegiatan tersebut. Namun status tahap pencemaran logam Santubong masih tidak diketahui. Oleh itu, kajian ini dilakukan untuk menilai kandungan logam seperti aluminium (Al), kadmium (Cd), kromium (Cr), tembaga (Cu), nikel (Ni) dan plumbum (Pb) dalam air dan sedimen semasa musim hujan dan musim kering. Kemudian untuk menentukan kandungan logam (Cd dan Pb) dalam ikan-ikan dan untuk mengetahui potensi risiko kesihatan terhadap manusia melalui pemakanan ikan-ikan dari tanah bencah Santubong. Tiga stesen iaitu Buntal, Penambir dan Demak dipilih dalam kajian ini dan persampelan dilakukan sekali pada setiap musim; musim hujan (April 2017) dan musim kemarau (Julai 2017). Parameter kualiti air fizikokimia dicatat di setiap stesen. Sampel air diambil menggunakan Van Dorn Water Sampler, sampel sedimen diambil menggunakan Grab sampler dan sampel ikan diambil menggunakan pukat tiga lapis. Sampel air dan sedimen dianalisis untuk Jumlah Karbon Organik (TOC). Sampel sedimen juga dianalisis untuk Jumlah Bahan Organik (TOM) dan Analisis Saiz Zarah (PSA). Risiko ekologi dinilai menggunakan Indeks Pengumpulan Geo (Igeo), Indeks Potensi Pencemaran (PCI) dan Faktor Pengayaan (EF). Sampel air ditapis dan diasidkan dan sampel sedimen dicerna. Ikan yang ditangkap dikenal pasti dan dicerna. Kemudian, semua sampel dianalisis menggunakan Spektrofotometer Penyerapan Atom Api (FAAS) untuk analisis logam. Indeks Faktor Bioakumulasi (BAF) dalam ikan ditentukan dan penilaian risiko kesihatan manusia diperiksa menggunakan Pengambilan Mingguan Toleransi Sementara (PTWI), Indeks

Risiko Kesihatan (HRI), Indeks Bahaya (HI) dan had keselamatan berdasarkan survei soal-selidik yang dilakukan di Santubong. Kekerapan Kejadian Makanan dilakukan untuk memeriksa diet ikan. Kandungan logam dalam air dan sedimen didapati bervariasi mengikut tempat dan musim iaitu jumlah hujan. Kandungan logam dalam air di antara 0.07-5.16 mg/L, 0.02-0.03 mg/L, 0.004-0.02 mg/L, BDL-0.004 mg/L, 0.01-0.04 mg/L dan 0.004- 0.01 mg/L untuk Al, Cd, Cr, Cu, Ni dan Pb. Kandungan logam dalam air berada dalam lingkungan MMWQCS dan NWQS kecuali Al. Kandungan logam dalam sedimen di antara 1918.94-3421.77 mg/kg, 0.06-0.09 mg/kg, 6.85-16.52 mg/kg, 2.45-6.81 mg/kg, 2.84-6.20 mg/kg dan 4.56-11.22 mg/kg untuk Al, Cd, Cr, Cu, Ni dan Pb. Pencemaran logam dalam sedimen berada dalam tahap rendah hingga sederhana. Terdapat 28 spesies ikan dikaji dan kandungan Cd adalah di antara 0.13-1.57 mg/kg sementara kandungan Pb adalah di antara 0.38-7.44 mg/kg. Kandungan logam dalam ikan juga didapati berkaitan dengan diet ikan. Analisis BAF menunjukkan bahawa Pb terkumpul lebih tinggi berbanding Cd. Kandungan Cd dan Pb dalam Arius maculatus dan Nibea soldado berbeza mengikut musim dan tempat. Sebilangan spesies ikan melebihi had PTWI dan had keselamatan yang disyorkan oleh FAO/WHO (2004) dan MFA (1983) untuk Cd dan Pb. Nilai HRI dan HI pada beberapa spesies ikan juga melebihi 1. Pengambilan ikan di kawasan ini dalam kuantiti yang banyak secara berterusan untuk jangka masa yang panjang boleh memberi kesan buruk kepada kesihatan manusia. Oleh itu, input antropogenik dari kegiatan-kegiatan yang dilakukan di kawasan ini mungkin telah menyumbang kepada kandungan logam dalam air, sedimen dan ikan dalam kajian ini. Maklumat kajian ini akan berguna untuk pengurusan kawasan tanah bencah yang berkesan supaya kawasan ini dapat dilindungi daripada pencemaran di masa depan.

Keywords: *Logam, air, sedimen, ikan, tanah bencah*