World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:4, No:5, 2010

Heavy Metal Concentrations in Fanworth (*Cabomba furcata*) from Lake Chini, Malaysia

Ahmad, A.K., Shuhaimi-Othman, M. and Hoon, L.P.

***Abstract*—**Study was conducted to determine the concentration of copper, cadmium, lead and zinc in *Cabomba furcata* that found abundance in Lake Chini. This aquatic plant was collected randomly within the lake for heavy metal determination. Water quality measurement was undertaken *in situ* for temperature, pH, conductivity and dissolved oksigen using portable multi sensor probe YSI model 556. The *C. furcata* was digested using wet digestion method and heavy metal concentrations were analysed using Atomic Absorption Spectrometer (AAS) Perkin Elmer 4100B (flame method). Result of water quality classify Lake Chini between class II to class III using Malaysian Water Quality Standard. According to this standard, Lake Chini has moderate quality, which normal for natural lake. Heavy metal concentrations in *C.furcata* were low and found to be lower than the critical toxic value in aquatic plants. One-way ANOVA test indicated the heavy metal concentrations in *C.furcata* were significantly differ between sampling location. Water quality and heavy metal concentrations indicates that Lake Chini was not receives anthropogenic load from nearby activities.

Keyword*---Cabomba furcata*, Heavy metal, Lake Chini, Water quality

I. INTRODUCTION

HEAVY metals contamination in aquatic system is increasing and received great concern globally and various studies on metals in aquatic system have been conducted [1,2]. Introduction of metals into aquatic system at accessive concentration could affect aquatic communities such as fish, benthos and aquatic plants. Most of aquatic plants exhibits excellent absorption rate and could accumulate metals at high concentration and finally disturb natural process. Metals release into the aquatic system could associated with suspended particle and absorped into the plant cells. Macrophyte has been reported as an excellent biomarker for metals pollution in aquatic system. This plant absorp metals in water system through root absorption process [3]. The metals were transported from water through cell wall and membraneous. Pollutants absorption by plants representing first stage bioavailable metal [4,5]. Therefore, metal absorption by plants can be sources of metals in other aquatic communities. Several previous studies demonstrated that some of aquatic macrophytes are able to accumulate metals to certain level of concentrations in their tissues [3,6,7].

Studies on metals absorption by aquatic plants were been undertaken at various plants such as *Pista stratioles, Spirodela intermedia, Lemna minor* and *Eichhornia crassipes.* However, most of studies were conducted in polluted ecosystems and they confirmed the potential of macrophytes as bioaccumulator [6,8,9]. Study on metal concentrations in pristine and ecosystem was not received great concern. Study on clean aquatic ecosystem could contribute to the baseline information on ambient metal concentration in aquatic plants.

This study was undertaken at one of two natural lakes in Malaysia. The lake was located away from urbanization and expected to receive very minimum anthropogenic load as a result from local communities' activities. This study was undertaken to determine the ambient metals concentration in submerge aquatic plants (*Cabomba furcata*) which was dominating the lake ecosystem. Result obtained expected to aid in establishing metals natural concentration in aquatic plants.

Authors are with School of Environmental and Natural Resource Sciences.Faculty of Science and Technology, Universiti Kebangsaan Malaysia. 43600 Bangi, Selangor.email: abas@ukm.my

II. METHOD

A. Study Area and Sampling Stations

Lake Chini is a second largest natural lake in Malaysia and consists of a series of 12 open water body. Lake Chini covers area approximately 150ha to 350 ha depending to the season change. The lake located from 3^0 22' 30" N to 3^0 28' 00" N and 102^0 52' 40" E to 102^0 58' 10" E (Fig. 1). Several main open waters are known as *Laut Gumun, Laut Pulau Balai, Laut Chenahan, Laut Tanjung Jerangkung, Laut Gunung Jerating, Laut Mempitih, Laut Kenawar, Laut Serodong, Laut Melai, Laut Batu Buruk, Laut Labuk* and *Laut Jemberau.* The Lake is located at south-east of Pahang and approximately 100km from Kuantan town. Lake Chini is naturally connected to the Pahang River through small river known as Chini River. Since Lake Chini is located a higher elevation, water flows from Lake Chini to Pahang River and only reverse during the flood season.

The lake receives water from several feeder rivers and [10] reported seven feeder rivers supply water to the lake. In addition, Lake Chini also receives high amount of rain water annually and a total of 2192 mm of rainfall was recorded in 2004 and 2260.2mm in 2005 [11]. Since, it not affected by urbanization, Lake Chini support high diversity of aquatic communities such as fish, benthos, aquatic plants, riparian trees and plankton. Variety of habitats found surround the lake create major habitat to the aquatic communities such as fishes. Lake Chini was reported to support up to 144 freshwater fish species although it was reported reduced recently.

Fanworth (*Cabomba furcata*) is dominance submerge aquatic plant found at the Lake Chini and this plant can be found all over the places within the lake. *Cabomba furcata*

was collected at eight different sampling stations representing littoral, sublittoral and profundal zones. Samples were collected in October 2007 for the heavy metal determinations. The fanworth was carefully removed from the lake bottom and was rinse with the lake water. The plants were then naturally dried in the clean place.

Lake water quality was determined during the sampling using multisensor probe YSI model 556. Dissolved oxygen, pH, conductivity and water temperature were measured at triplicates. Calibration and measurement were done according to the [12].

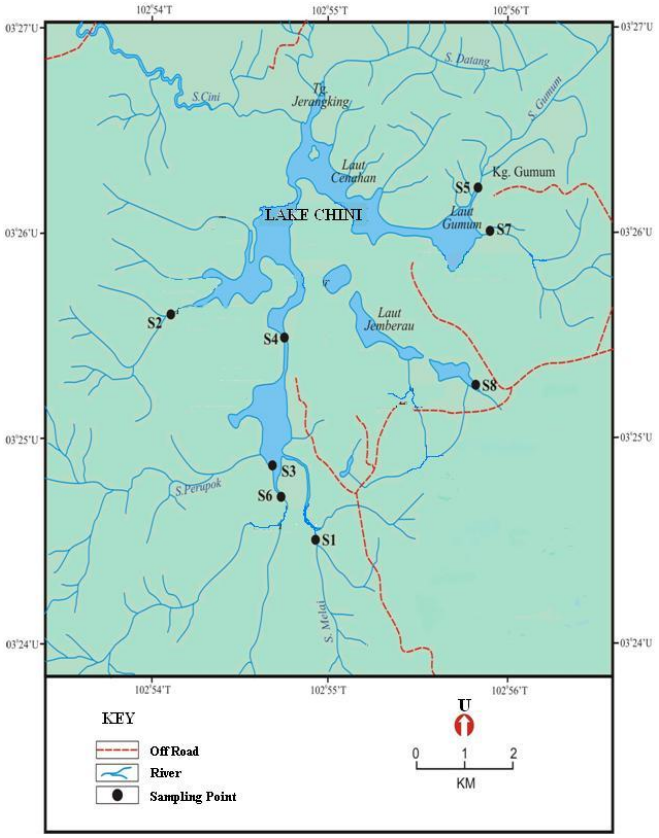

Fig. 1 Lake Chini and sampling stations

B. Laboratory Analysis

All equipments were acid soaked (10% nitric acid) for minimum 24 hours, washed with distill and deionised water prior to dried in the oven.

C. Aquatic plant digestion

In the laboratory, samples were rinsed with deionised water and leaf and stem were separated. Samples were then dried in oven for 70°C until constant weight achieved. This will avoid contamination by bacteria and fungal. Dry and clean fanworth were cut into small peice before digested using [13]. Leaf and stem were prepared in three replication and each replicate has dry weight from 5g to 10 g.

A combination of nitric acid and perclorid acid was for digestion, where 40ml of nitric acid (65%, analytical grade) was added into the sample beakers. Samples were left for 24 hours before heated on the sand batch. Perclorid acid (20ml, 65%, analytical grade) was added in the beakers to complete the digstion. Samples were heated until all samples digested and yellowish mixture formed. Cold samples were then contrifused for 30 minutes and filtered through 0.45 pore size filter paper. The filtrates were then analysed for heavy metals concentration using atomic absorption spectrophotometric (AAS), Perkin Elmer model 4100B.

III. RESULT

A. Water Quality

Average water quality for the lake is shown in Table 1. Lake water temperature was ranged from 27.2 ^{o}C to 32.9 ^{o}C with the mean 30.1 $\pm$ 1.27^{o}C. Wide ranges of water temperature was detected due to variable dept within the lake. Lake Chini is shallow natural lake and easily affected by heat. Reading muasured suring dusk can be very differ from down.

Water pH ranged from 5.4 to 6.8 and average from eight sampling stations was 6.0 $\pm$ 0.45. The water was slightly acidic however still within natural range of concentrations. The presence of carbonat and bicarbonat ions as result of rapid biodegradation in the lake reduce the alkalinity. Each sampling site exhibited different water pH and one-way ANOVA indicated a signficant different between sampling sites ($p>0.05$, $\alpha=0.05$).

Water conductivity was recorded ranges from 13 µS/cm hingga 51 µS/cm. Water conductivity characterised by major and minor ionics in the water. [14] reported that conductivity in natural water is ranges from 20 to 1500 µS/cm. All sampling sites have conductivity value within natural range of concentration.

Dissolved oxygen concentrations in lake water ranged from 3.8 mg/l to 7.4 mg/l. Lake Chini was reported to have wide range of dissolved oxygen [15]. Since the lake is shallow, the influence of water depth is negligible. Schmitz [16] suggested average dissolved oxygen in unpolluted water was from 4 mg/l to 8 mg/l and result of this study is within the proposed ranges.

TABLE I
PHYSICAL WATER QUALITY DATA MEASURED *IN SITU*

Parameter	Average ± SD
temperature (^{o}C)	30.1 $\pm$ 1.27
pH	6.0 $\pm$ 0.45
conductivity (µS/cm)	32.7 $\pm$ 11.56
Dissolved (mg/L)	5.3 $\pm$ 0.88

B. Heavy Metal in Cabomba furcata

Average Cu, Cd, Pb and Zn concentrations in *C. furcata* from Lake Chini is presented in Table 2. Data presented are average from three replications. Lead was found the highest in *C. furcata* with the average of 6.36 $\pm$ 2.09 µg/g followed by Cu that was 3.92 $\pm$ 0.600 µg/g and Zn 2.25 $\pm$ 0.58 µg/g. In averall, heavy metal concentrations in *C. furcata* was in the sequence of Pb > Cu > Zn > Cd. Each metal was detected at

various concentration between sampling stations. Sampling station 8 was detected to have highest Cd and Pb, whereas station 7 and station 6 having the highest Cu and Zn respectively.

IV. DISCUSSION

A. Water Quality

Lake water quality demonstrates that Lake Chini has moderate to good water quality. Results obtained were compared to Malaysian water quality standard and most water quality parameters classify the lake in class II except dissolved oxygen put Lake Chini in class III. Although some water quality parameters were detected at high variation spatially, the average was within the natural range of concentrations. Lake Chini is a natural lake and has shallow water body. The average water dept is less than 2.5m [15]. This made the lake easily affected by the water temperature. In addition, according to [14], amount of dissolved materials in water column could determine water temperature. High dissolved materials will enhance heat absorption and increase water temperature. Water temperature determine biochemical process and chemical reactions in water [17]. Therefore most of water quality parameters were detected in wide range of concentrations. One-way ANOVA test indicates all water quality parameters were significantly differ between sampling station ($p < 0.05$, $\alpha = 0.05$). However, results obtained indicated that Lake Chini has moderate to good water quality and similar result was reported by [15].

B. Heavy Metals in C. furcata

Metals absorption in *C. furcata* was differ spatially although within the same species [18] . Submerge aquatic plants likes *C. furcata* exhibit better metals absorption as compared to the floating leaf and emergence plants [19]. Results from this study demonstrated that Pb, Zn, Cu and Cd were detected at low concentrations and within the natural range of concentrations.

Various studies reported level of toxicity for Pb, Zn, Cu and Cd are 30 µg/g [20], 230 µg/g [21], 20 µg/g [22] and 5 µg/g [20] respectively. However, different species has different absorption rate an only rough comparison can be undertaken to estimate the level metals in aquatioc plants. Result from this study demonstrates that although metal concentrations were varies spatially, but none of metal found exceed the toxic concentrations. Metal concentrations in *C. furcata* were found lower than critical values as sugested by [23] and [20]. Lead was found the highest in *C. furcata*, followed by Cu, Zn and Cd respectively.

TABLE II
MEAN Cu, Cd, Pb AND Zn in *C. furcata* (µg/g dry weight)

Station	Cu	Cd	Pb	Zn
S1	3.64 ± 0.01	0.13 ± 0.01	4.43 ± 0.22	1.85 ± 0.31
S2	4.17 ± 0.01	0.16 ± 0.01	5.86 ± 0.19	3.08 ± 0.09
S3	3.04 ± 0.05	0.11 ± 0.01	4.02 ± 0.05	1.46 ± 0.12
S4	3.55 ± 0.05	0.12 ± 0.02	5.50 ± 0.27	1.51 ± 0.13
S5	3.77 ± 0.05	0.16 ± 0.01	6.45 ± 0.08	1.87 ± 0.26
S6	4.74 ± 0.03	0.17 ± 0.00	6.03 ± 0.27	2.97 ± 0.04
S7	4.86 ± 0.01	0.19 ± 0.01	7.55 ± 0.79	1.86 ± 0.06
S8	3.58 ± 0.04	0.24 ± 0.03	10.97 ± 0.46	2.38 ± 0.48
Mean	3.92 ± 0.60	0.16 ± 0.04	6.36 ± 2.09	2.25 ± 0.58
Range	3.00 – 4.87	0.09 – 0.27	3.97 – 11.37	1.32 – 3.18

V. CONCLUSION

Lake Chini is one of the natural lake in Malaysia and not receives signficance impacts from human activities. The lake water quality ranges from good to medium quality which indicates natural conditions. Heavy metal concentrations in *C. furcata* were low which support the assumption that the lake is free from metals contaminations.

ACKNOWLEDGEMENT

Authors would like to thank you to Malaysia Ministry of Science, Technology and Innovative for supporting this research (04-01-02-SF0428).

REFERENCES

[1] Karadede, H. & Ünlü, E.**,** Concentrations of some heavy metals in water, sediment and fish species from the Atatürk Dam Lake (Euphrates), Turkey**,** *Chemosphere,* vol. 41**:** 1371-1376, 2000.

[2] Wagner, A. & Boman, J., Biomonitoring of trace elements in muscle and liver tissue of freshwater fish, *Spectrochimica Acta Part: Atomic Spectroscopy*, vol. 58: 2215-2226, 2003**.**

[3] Rai, U.N., Tripathi, R.D,. Vajpayee, P., Oandey, N., Ali, M.B. & Gupta, D.K., Cadmium accumulation and its phytoxicity in *Potamogeton pectinatus* L. (Potamogetonaceae), *Bull Environ Contam Toxicol,* vol. 70: 566–575, 2003.

[4] Tessier, A., Buffle, J. & Campbell, P.G.C., Uptake of trace metals by aquatic organisms. In. Buffle, J. & De Vitre, R.R. *Chemical and biological regulation of aquatic system,* pp. 197-230. Lewis Publishers, 1994.

[5] Yang, Handong., Rose, N. L. & Battarbee, R.W., Distribution of some trace metals in Lochnagar, a Scottish mountain lake ecosystem and its catchment. *The Science of The Total Environment,* vol. 285: 197-208, 2001.

[6] Samecka-Cymerman, A. & Kempers, A.J., Toxic metals in aquatic plants surviving in surface water polluted by copper mining industry, *Ecotoxicol Environ Safe,* vol. 59: 64–69, 2004.

[7] Prasad, M.N.V., Sajwan, K.S. & Naidu, R., *Trace elements in the environment biogeochemistry, Biotechnology, and Bioremediation,* hlm. 451-471. London: Tylor & Francis Group, 2006.

[8] Valitutto RS, Sella SM, Silva EV, Pereira RGA, Miekeley N., Accumulation of metals in macrophytes from water reservoirs of a power supply plant, Rio de Janeiro State, Brazil. *Water Air Soil Poll* **178(1-4)**: 89-102, 2007.

[9] Sahu RK, Naraian R, Chandra V., Accumulation of metals in naturally grown weeds (aquatic macrophytes) grown on an industrial effluent channel. *Clean-Soil Air Water,* vol. 35, no 3: 261-265, 2007.

[10] Tan, C.C. & Barzani Ghasim, M., *Assessment of hydrology and water quality in river basin between two seasons in lake Chini, Pahang*. Paper presented at the Fifth Graduate Colloquium , Faculty of Science and Technology, UKM, Bangi, Selangor, Malaysia, July 2005.

[11] Malaysian Meteorological Service, *Annual Reports of Malaysian Meteorological Department.* Ministry of Science, Technology and Innovation, Malaysia, 2005.

[12] APHA, *Standard methods for the examination of water and wastewater*. Ed. ke-12. Washington: American Public Health Association, 1985.

[13] Ganje, T.J. & Page, A.L., Rapid acid dissolution of plant tissue for Cd determination by atomic absorption spectrophotometry. *Absorp. Newsletter* , vol. 13: 131-134, 1974.

[14] Boyd, C.E., *Mutu Air Kolam Ikan di kawasan beriklim Panas.* Terj. Mohd Salleh Kamaruddin, Siti Shapor Siraj & Noor Azhar Shazili. Kuala Lumpur: Dewan Bahasa dan Pustaka, 1990.

[15] Mohamad Shuhaimi-Othman, Eng, C.Lim and Idris Mushrifah Water quality changes in Chini Lake, Pahang, West Malaysia. *Environ. Monit. Assess*, vol. 131: 279-292, 2007.

[16] Schmitz, R.J., *Introduction to water pollution biology*, Gulf Publishing Company, Houston, 1995.

[17] Karavoltsos, S., Sakellari, A., Mihopoulos, N., Dassenakis, M. & Scoullos, M.J., Evaluation of the quality of drinking water in regions of Greece, *Desalination,* vol. 224: 317-329, 2008.

[18] Deng, H., Ye, Z.H. & Wong, M.H., Accumulation of lead, zinc, copper and cadmium by 12 wetland plant species thriving in metal-contaminated sites in China, *Environmental Pollution* , vol. 132: 29-40., 2004.

[19] Albers, P.H. & Camardese, M.B., Effects of acidification on metal accumulation by aquatic plants and invertebrates in constructed wetlands. *Environmental Toxicology and Chemistry* , vol.12, no**.** 9: 959–967, 1993.

[20] Kabata- Pendias, A. & Pendias H., *Trace elements in soils and plant*. Ed. ke-3. Boca Raton, Florida: CRR Press LLC, 2000.

[21] Long, X.X., Yang, X.E., Ni, W.Z., Ye, Z.Q., He, Z.L., Calvert, D.V. and Sftoffella, J.P., Assessing zinc thresholds for phytoxicity and potential dietary toxicity in selected vegetable crops. *Communications in Soil Science and Plant Analysis,* vol. 34**:** 1421–1434, 2003.

[22] Borkert, C.M., Cox, F.R. & Tucker, M.R., Zinc and copper toxicity in peanut, soybean, rice and corn in soil mixtures. *Communications in Soil Science and Plant Analysis,* vol**.** 29**:** 2991–3005, 1998.

[23] Bowen, H.J.M., *Environmental chemistry of the elements*. London: Academic Press, 1979.