Toxicology Reports 5 (2018) 288–295

Contents lists available at ScienceDirect

Toxicology Reports

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

# Bioaccumulation of heavy metals in fish species from the Meiliang Bay, Taihu Lake, China

Sivakumar Rajeshkumar, Xiaoyu Li*

*College of Life Science, Henan Normal University, Xinxiang, Henan 453007, China*

ARTICLE INFO

*Keywords:*
Bioaccumulation
Heavy metal
*Cyprinus carpio*
*Pelteobagrus fluvidraco*
Taihu Lake

ABSTRACT

In the present study, the bioaccumulation of heavy metals (Cr, Cu, Cd, Pb) content were determined in freshwater edible fishes *Cyprinus carpio* Linnaeus and *Pelteobagrus fluvidraco,* which were caught from the Meiliang Bay, Taihu Lake, a large, shallow and eutrophic lake of China. The results showed that the Cr, Cu, Cd and Pb content in the edible parts of the two fish species were much lower than Chinese Food Health Criterion (1994). However, the results showed marked differences in the four analyzed metal content between the two species and different tissues as well as significant variations. Pb content were the highest in the liver of fishes, Cd contents were almost the same in all organs of fishes, Cr contents mainly enriched in the kidney and liver, Cu contents were the highest in gills, However, the total metal bioaccumulation were greatest in the liver, gills and the lowest in the muscle. Although the total accumulations were highest in *P. fluvidraco* compare then *C.carpio.* This investigation indicated that fish products in Meiliang Bay, Taihu Lake were still safe for human consumption, but the amount consumed should be controlled under the Chinese Food Health Criterion to avoid excessive intake of Pb. Further, this is the first report on seasonal distribution of heavy metals and proximate compositions of commercialized important edible fishes from Meiliang Bay, Taihu Lake, China.

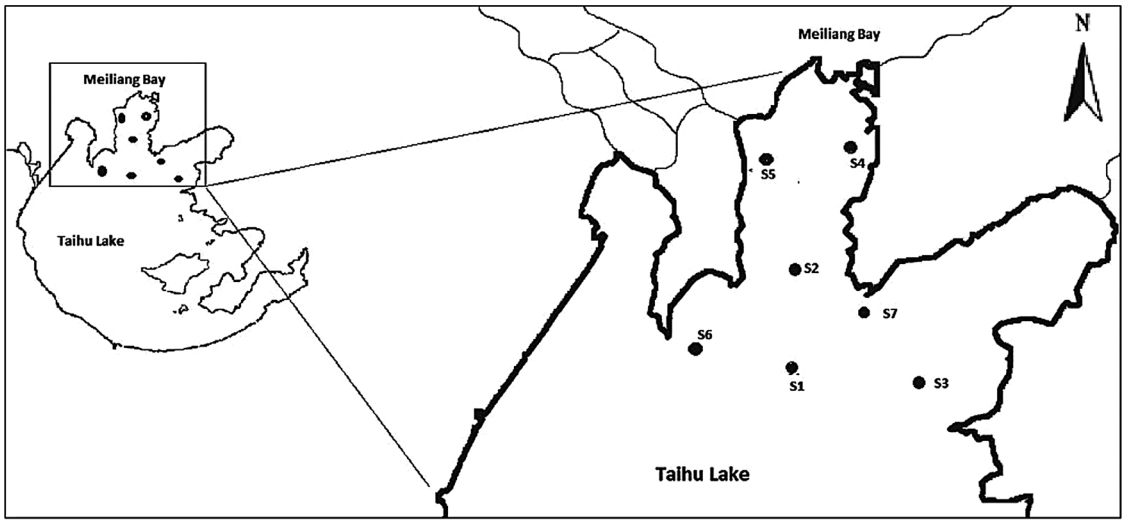
## 1. Introduction

In the recent years, world consumption of fish has increased simultaneously with the growing concern of their nutritional and therapeutic benefits. In addition to its important source of protein, fish typically have rich contents of essential minerals, vitamins and unsaturated fatty acids Mederos et al., 2012. The American Heart Association recommended eating fish at least twice per weak in order to reach the daily intake of omega-3 fatty acids [1].

Two main ways by which heavy metals enter the aquatic food chain are by direct consumption of water and food through the digestive tract and non-dietary routes across permeable membranes such as the muscle and gills [2]. Therefore levels in fish usually reflect levels found in sediment and water of the particular aquatic environment from which they are sourced [3]; and time of exposure [4]. Fish have the ability to accumulate heavy metals in their tissues by absorption along gill surface and kidney, liver and gut tract wall to higher levels than environmental concentration [4]. Accumulation of heavy metals by organisms may be passive or selective; and differences in accumulation of heavy metals by organisms could be as a result of differences in assimilation, egestion or both [5]. Non-essential heavy metals such as Cadmium (Cd), Mercury (Hg) and Lead (Pb) have no known essential role in living organisms; exhibit extreme toxicity even at very low (metal) exposure levels and have been regarded as the main threats to all forms of life especially human health [6,7]. Toxic effects occur when excretory, metabolic, storage and detoxification mechanisms are no longer able to counter uptake [8] eventually resulting in physiological and histopathological changes [2,9–11]. These changes can also be altered by water physico-chemistry [4]. Entry of heavy metals into the organs of a fish mainly takes place by adsorption and absorption; the rate of accumulation is a function of uptake and depuration rates [4]. Non-essential metals, aside from being toxic and persistent, are bioaccumulated and internally regulated using different strategies such as active excretion and storage [12]. Significant variations in the levels of non-essential heavy metals have been reported between organs and species of fish inhabiting the same freshwater body: Lake Balaton, Hungary [13]; Iskenderun Bay, Turkey [14]; Three Gorges Reservoir, China [15]. Elevated levels of toxic heavy metals have been reported from areas experiencing increasing settlement, traffic and agricultural activities [5,4]. The levels of non-essential trace elements in fish are important because fish is an important source of food for the general human population; fish from freshwater bodies receiving industrial effluents have been reported to be unfit for human consumption because of high tissue levels of some heavy metals [16,17,8,18,19]. In

* Corresponding author.
*E-mail addresses:* kumarhnu2015@yahoo.com (S. Rajeshkumar), lixiaoyu65@263.net (X. Li).

https://doi.org/10.1016/j.toxrep.2018.01.007
Received 27 September 2017; Received in revised form 16 January 2018; Accepted 22 January 2018




| Sampling sites | Land use type |
|---|---|
| S1 - Tuo shan | North outer bay were believed to be affected by intense levels of anthropogenic activity. |
| S2 - Mei liang hu | Were located in the central area of the lake and the reservoirs |
| S3 - Sha zhu nan | Drinking water resource area free of nearby factories and other pollution sources. |
| S4 - Xiao wan li | North of bay (former drinking water resource, now stop). |
| S5 - Ma shan shui chang | West of bay (former drinking water resource, now stop). |
| S6 - Long tou zhu | North of bay usually suffer heavy blooms in summer. |
| S7 - Wu tang men | North of bay where there is less anthropogenic pollution coming from the surrounding land. |

**Fig 1.** Categories of sampling sites based on pollution sources from different land use types in the Meiliang Bay, Taihu Lake, China.

order to protect aquatic biota, it is necessary to determine contamination levels of trace elements through chemical biomonitoring and evaluation of biomarkers that represent early indicators of biological effects [4]. Certain fish species maybe better bioindicators of specific heavy metal contamination compared to others [20,21].

The concentrations of heavy metals in fish have been extensively studied over the past several decades. Research has shown that extent of accumulation of heavy metals in fish is dependent on the metal types, fish species, and the tissues respectively [22,23]. Water chemistry [24] directly affects the accumulation of heavy metal in fish. Sediment is also know to an important factor heavy metal accumulation in fish, as it is considered as the major source of contaminants for bottom dwelling and bottom feeding aquatic organisms [25], which in turn represents the concentrated source of metals in the diet of fish.

Fish is an important part of the human diet because of its high nutritional quality [26]. However, nonessential trace elements in the edible tissues of fish have been detected due to be bioaccumulation in organism and the highly persistent and non-biodegradable properties [27,28]. However, fish are relatively situated at the top of the aquatic food chain; therefore, they normally can accumulate heavy metals from food, water and sediments [29,30]. The content of toxic heavy metals in fish can counteract their beneficial effects; several adverse effects of heavy metals to human health have been known for long time [31]. This may include serious threats like renal failure, liver damage, cardiovascular diseases and even death [32,33]. Therefore, many international monitoring programs have been established in order to assess the quality of fish for human consumption and to monitor the health of the aquatic ecosystem [34]. According to the literatures, metal bioaccumulation by fish and subsequent distribution in organs is greatly inter-specific. In addition, many factors can influence metal uptake like sex, age, size, reproductive cycle, swimming patterns, feeding behavior and living environment (i.e., geographical location) [35,14,30]. Hence, fishes are considered as one of the best indicator of heavy metal contamination in coastal environment [36,37].

Taihu Lake is the third largest freshwater lake China, is located in the Yangtze delta plain on the border of the Jiangsu and Zhejiang provinces of eastern China. It plays an important role in flood control, water supply, and fisheries [38]. Rapid industrial and economic development has occurred around the lake since the 1980s. Yuan et al. [39] reported that Taihu Lake was moderately polluted by heavy metals based on their study of sediments whereas increased nutrient inputs related to population and economic growth have led to eutrophication. Most pollutants come from rivers discharging into Meiliang Bay and other parts of the Taihu Lake [40]. The northern and western parts of Taihu Lake are often covered by algae blooms in summer, autumn and even spring [41]. A lot of researches have been carried on the pollution of Taihu Lake and its catchment [42–49], but most of them considers the issue of sediment pollution. Zhong et al. [50] observed that denitrification in the sediment of Meiliang Bay, Taihu Lake. However, earlier studies in Taihu Lake recorded on the levels of contamination of heavy metal concentrations, especially chromium, copper and lead [51,50,52,53,49]. The average concentration of chromium in water samples during summer was 0.35 μg/L and in winter was 2.84 μg/L. Copper concentration in water samples was 0.71 μg/L in both the seasons. The average concentration of lead in sediments during summer was 0.58 μg/g and in winter it was 8.53 μg/g. Since, the study area is being considered as an important source for fishery, the presence of toxic heavy metals in water and sediments would be the primary source for the biomagnifications of metals in fish, invertebrates and other aquatic plants animals and cause ill effects to those who consume the contaminated fish [52,54]. The primary goal of this study was to determine the bioaccumulation and seasonal variation of four heavy metals, including Cr, Cd, Cu and Pb in the fish species *C. carpio* Linnaeus and *P. fluvidraco* collected from Meiliang Bay, Lake Taihu. We choose Meiliang Bay as research object, this could help us understand enrichment behavior of heavy metals in shallow lake ecosystems and emphasize the need to discard the most polluted tissues of the fish.