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# Assessment of Lead Content in Water, Sediment and Muscle of the Fish (*Mystus gulio*) of Hooghly River Downstream from Batanagar to Birlapore, South 24 Parganas

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**Abstract:** ***The present study was attempted to analysis the concentration of lead (Pb) in water, sediment and muscles of fish specimen, Mystus gulio Ham. – Buch. inhabited in the river Hooghly downstream near Batanagar, Budge Budge and Birlapur, as middle stretch of West Bengal. The concentration of Pb was estimated in water, sediment, and muscles of studied fish specimen by using atomic absorption spectrophotometer. The results indicated that the value of metal Pb as <0.1mg/L in water, varied between 4.62 to 14.69 (mg/Kg) in the sediment and 3.58 to 23.41 (mg/Kg) in the muscle of fish specimens in which water is observed within the limit but sediment and muscle exceeded the limit of international standards. Interestingly, bioaccumulation factor was within the category of <1000 as no probability of accumulation. It is suggested the continuous biomonitoring and bioaccumulation study with other heavy metals to know the health status of other inhabited fish species in the study sites of river Hooghly. It should also require to further study the synergistic effect of Pb when present with other heavy metals.***

**Keywords:** Bioaccumulation, *Mystus gulio*, Muscle tissue, Pb content, Riverine fish

## 1. Introduction

The river Hooghly is also known as river Ganges, and it is largest riverine ecosystem of India [1]. According to Bonnail et al. [2], about 80% of drainage discharge observeddue to Indian monsoon [3]. Many past studies revealed that this river water and sediment is mixed with different types of heavy metals such as Zn, Fe, Cu, Pb, Cd, Hg, etc. In the upstream and downstream sites [1, 2, 4 – 12]. Generally, these metals have tendency to accumulate in the vital organs of aquatic biota especially fish species [6, 12- 15]. The accumulation in fish is a matter of great concern because of edible purpose. Among these metals, lead (Pb) is well known mutagen and carcinogen, causes cancer in different tissues [16].

From earlier studies it was established that in the upstream sites such as Varanasi, Allahabad, Mirzapur, and Kanpur of Uttar Pradesh, India of river Ganges heavy metals accumulation in gills, liver, and muscle of inhabited fish species viz. *Cirrhinus mrigala*, *Cirrhinus reba*, *Catla catla*, *Labeo rohita*, *Crossocheilus latius*, *Clupisoma garua*, *and Mystus tengara [*14], whereas in upper stretch of West Bengal six types of fishes viz. *Apocryptes bato*, *Glossogobius guris*, *Gudusia chapra*, *Mastacembelus armatusy*, *Eutropiichthys vacha*, *Cynoglossus punticeps* accumulated heavy metals (6) and downstream sites near estuariesmetals like Zn, Cu, Pb and Cd were found in the muscles of edible finfish species (*Polynemus paradiseus*, *Tenualosa ilisha*, *Liza parsia*, *Liza tade* and *Stolephorus commersonii*) collected near islands of Hoogly river and other estuaries [13], also in the muscle of fish (*Mystus cavasius*) in the suburban site of Kolkata (65 - 70Km from estuary) [12]. Beside many metals, most of the studies were selected Pb accumulation in the fish species of Ganga or Hoogly river.

The present study was attempted to estimate the concentration of Pb in water, sediment, and muscle of fish (*Mystus gulio*) inhabited in the three suburban sites of downstream of river Hooghly, West Bengal, India.

## 2. Materials and Methods

### 2.1 Selection of study area

The study sites were selected in three places namely Batanagar (Bt), Budge Budge (Bg) and Birlapur (Br) sites in the downstream of river Hooghly, West Bengal, India. The study sites are the part of suburban area near Kolkata and located at $22^0$30′N and $88^0$13′E, $22^0$29′N and $88^0$11′E, and $22^0$24′N and $88^0$08′E latitude and longitude, respectively. Each study site further categorized into two zones as 1 and 2. The google earth image of different study sites is presented in Fig 1.


**Figure 1:** An image of study sites (source: Google earth)

### 2.2 Water and sediment sample collection

Water and sediment samples were collected from the two different zones in each above - mentioned study site. After collection it was transported to the laboratory for analysis of lead (Pb).

### 2.3 Collection of fish specimen

The fish specimen was selected commonly known as Gulse tangra and scientific name *Mystus gulio* is a catfish under family Bagridae of order Siluriformes. It feeds mainly of crustaceans and insects; insect populations of *Chironomus* sp. and *Micronecta* sp. [17, 18] and it was observed that they also fed debris, zooplanktons, zoo benthos, other benthic organisms, fish eggs and larvae [18, 20]. It has high demand as edible fish due to lower price and delicious taste [18, 21, 22].

### 2.4 Collection of muscle tissue and process for analysis

The fish *M. gulio* samples were collected from nearby fish catcher along the river basin of Hooghly. The fishes were ranging from 17 - 25 cm in length and weighing between 80 - 100gm. All the fishes were collected just died and muscles were dissected out, kept in zip - lock plastic and transported to the laboratory for Pb analysis.

### 2.5 Estimation of Pb in the samples

The method of Pb analysis in water, sediment and fish muscle was done as per protocol in the American Public Health Association published in 2018. Each sample was digested in concentrated nitric acid and analyzed the Pb by using an atomic absorption spectrophotometer (AAS model: Agilent Technology 200 Series AA).

### 2.6 Measurement of bioaccumulation factor of muscle tissue

Different bioaccumulation factors viz. Bioaccumulation factor (BAF) for water and sediment and degree of variability as per Coefficient of variation (CV%) were measured by using previous studies [23 25]:

BAF for water = metal concentration in muscle tissue (mg/Kg) ÷ metal concentration in water (mg/l).
BAF for sediment = metal concentration in muscle tissue (mg/Kg) ÷ metal concentration in sediment (mg/Kg).
The degree of variability of metal levels in the muscle tissues determined by Coefficient of variation (CV%) = Standard deviation × 100÷ Mean.

### 2.7 Statistical analysis

For statistical analysis, the data will express as means ± standard deviation (M ± SD) and comparison was done between the site of each study area as well as upstream and downstream study sites by using PAST (Paleontological Statistics version 3.26) software developed by Hammer et al. [26]. One - way analysis of variance (ANOVA) was studied to compare sites specific Pb accumulation in the muscle of specimens. The level of significance was considered at $P<0.05$.

## 3. Results

In the present study the heavy metal Pb content (ppm) was estimated in water, sediment, and muscle of fish (*M. gulio*) followed by different indices of bioaccumulation factors in the various study sites.

Table 1 describes the value of Pb metal (mg/L) in river water samples of six study sites and were observed <0.1 mg/L as very lower concentration within the surface water quality standard prescribed by Central Pollution Control Board (CPCB), 1979 and the Bureau of Indian Standards (BIS), 1982.

**Table 1:** Concentration of Pb in water of river Hooghly

| Bt1 (mg/L) n = 4 | Bt2 (mg/L) n = 4 | Bg1 (mg/L) n = 4 | Bg2 (mg/L) n = 4 | Br1 (mg/L) n = 4 | Br2 (mg/L) n = 4 |
|---|---|---|---|---|---|
| <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

Fig 1 exhibits the content of Pb (Mean ± SD) in the river sediment samples (mg/Kg) of six study sites. Maximum values of about 12.5± 2.4 followed by 10.5 ± 0.6in the study site of Br2 and Br1 and minimum values of about Bg2 (5.5 ± 0.9) and Bg1 (6.4 ± 1.1) followed by the sites of Bt1 (8.2 ± 0.2) and Bt2 (8.2 ± 1.3), respectively.

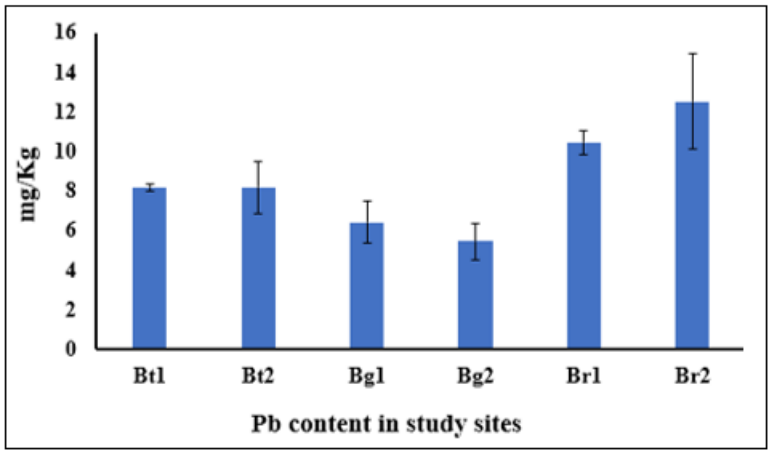


**Figure 1:** Concentration of Pb in sedimentof different study sites of river Hooghly (n = 4 for each study site)

Fig 2 exhibits the content of Pb (Mean ± SD) in the muscle samples (mg/Kg) of fish specimens in six study sites. Maximum values of about 17.6 ± 6.2 followed by 17.1 ± 6.6 in the study site of Br2 and Br1 and minimum values of about Bg2 (8.6 ± 4.2) and Bg1 (8.4 ± 4.2) followed by the sites of Bt1 (9.4 ± 1.7) and Bt2 (9.5 ± 1.7), respectively.

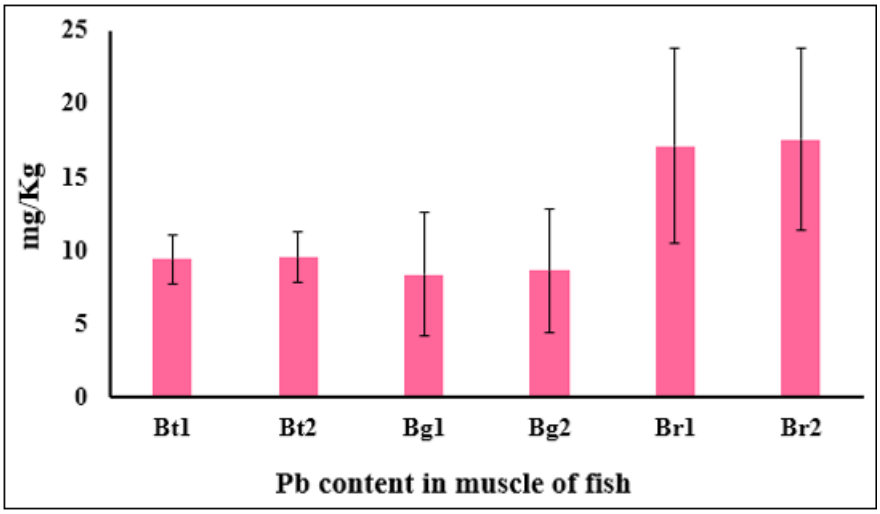


**Figure 2:** Concentration of Pb in muscle of *M. gulio* in different study sites (n = 5 for each study site)

In Table 2, in the case of bioaccumulation factor (BAF) for water, Pb was obtained maximum value in Br2 (175.60) site and Br1 (171.40) followed by Bt2 (95.40) site and Bt1 (94.20) site while minimum value in Bg1 (83.90) site and Bg2 (86.40) site whereas BAF for sediment for Pb was obtained maximum value in Br1 (1.64) site and Bg2 (1.58) followed by Br2 (1.40) site and Bg1 (1.31) site while minimum value in Bt1 (1.15) site and Bt2 (1.17) site, respectively.

**Table 2:** Bioaccumulation factor for water and sediment and coefficient of variation in different study sites for Pb

| Bt1 | Bt2 | Bg1 | Bg2 | Br1 | Br2 |
|---|---|---|---|---|---|
| **BAF water** | | | | | |
| 94.20 | 95.40 | 83.90 | 86.40 | 171.40 | 175.60 |
| **BAF sediment** | | | | | |
| 1.15 | 1.17 | 1.31 | 1.58 | 1.64 | 1.40 |
| **CV (%)** | | | | | |
| 17.77 | 17.58 | 50.26 | 48.46 | 38.52 | 35.26 |

BAF = Bioaccumulation factor; CV = Coefficient of variation

Table 3 determines one - way ANOVA results for the value of Pb metal in different study sites and were observed highly significant level at P<0.01. Fig 3 exhibits the normal probability plot of one - way ANOVA results.

**Table 3:** One way ANOVA result of Pbcontent in fish muscle of different study sites

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between groups | 470.145 | 5 | 94.0291 | 4.594 | 0.004 |
| Within groups | 491.254 | 24 | 20.4689 | | |
| Total | 961.399 | 29 | | | |

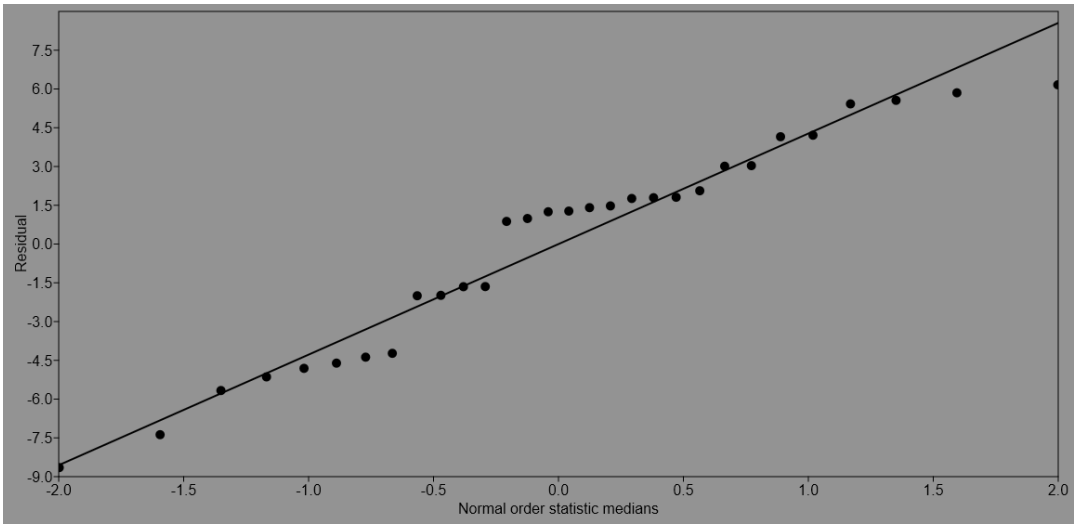


**Figure 3:** Normal probability plot between the groups for data of muscle Pb accumulationin different study sites (P<0.01)

## 4. Discussion

In the present study, assessment of heavy metal Pb content in the water and sediment of six different sites at middle stretch of river Hooghly at West Bengal. It was also determined the bioaccumulation of Pb in the muscle of inhabited fish specimen (*M. gulio*).

The present findings indicated that Pb content in the water of river Hooghly was <0.1 mg/L in all six study sites, which is within the limit of BIS, 1991 [27]. A similarity was observed in the earlier studies in river Hooghly [5, 6, 12].

In case of the Pb content in the sediment of river Hooghly, it was varied between 4.62 to 14.69 mg/Kg in the present analysis, which is beyond the permissible limit of WHO (limit = 5.0 mg/Kg) but within the threshold values of 40 and 35 µg/gm by USEPA, 1999 [28] and CCME, 1999 [29]. Interestingly, previous studies reported that the Pb content in the sediment between Budge Budge (4.03 - 11.5 mg/Kg) to Diamond Harbour (5.54 - 8.98 mg/Kg) was closely similar with the present findings [2] but obtained lower value from earlier study [12] and it was observed lower value ranged between 0.099 - 0.109 mg/Kg in the area of upper stretch of West Bengal near Rishra - Konnagar area [6].

Among several fish species, *Mystus gulio* is a common catfish found in the river Hooghly almost in all seasons. In the present results, the content of Pb in the muscle ranged between 3.58 to 23.41 (mg/Kg) of fish specimens of six study sites, which is exceeded the limit of 2.0 mg/Kg in food [30]. In the present study, the possibilities of Pb content in the muscle was higher in the studied specimen because they feed debris, zoo - benthos, etc. [18, 19] and during feeding they contact majorly with the sediments. The Pb content of muscle of other fish species was higher in the previous studies compared to present results of fish specimen inhabited river Hooghly [12, 13]. But it was observed from earlier study that nearly close value of Pb content in muscle of downstream site [12].

A previous study [24] reported the categorization of BAFs for heavy metals as BAF< 1000 is no probability of accumulation, 1000< BAF <5000 is bio - accumulative, and BAF >5000 is extremely bio - accumulative. The present results obtained for muscle accumulation of Pb is safe as per categorization. But it was observed a tendency to accumulate Pb in the muscle of this specimen. Moreover, one - way ANOVA results indicated a significant difference between the groups and within the groups for site - specific Pb accumulation in the muscle of studied fish specimen, which is supported by another researcher [31].

## 5. Conclusion

It is concluded from the present results the Pb concentration in water within the permissible limits but exceeded within the sediment as per the limit of WHO. In case of the Pb accumulation in muscle of studied specimen was also exceeded the limit of WHO but the BAF value was found no probability of accumulation (<1000) while there was observed a tendency of Pb accumulation in the muscle tissue. It is suggested that the continuous biomonitoring and bioaccumulation study with other heavy metals to know the health status of other inhabited fish species in the study sites of river Hooghly. It should also need to study the synergistic effect of Pb when present with other heavy metals.

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**Conflict of interest**
Author declare no conflict of interest.

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