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Determination of Lead (Pb) in Different Organs of Some Edible Fish Collected From Fish Markets of Patna, Bihar

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Abstract: Fishes play a vital role in food and nutritional security for humans as they contain a large amount of protein, several essential micronutrients, vitamins, and mineral salts (calcium, iodine, zinc, iron, and selenium). However, fish can accumulate heavy metals from polluted water bodies and transfer them to humans through the food chain. The objective of our study was to assess the concentration of Lead (Pb) in the organs of Clarias batrachus Manager), Catla catla (catla), and Labeo rohita (rohu) collected from local fish markets of Patna, Bihar. Samples were collected in March 2022. Atomic Absorption Spectrophotometer determined the level of Lead. We observed that the accumulation of Lead ranged from 0.005-0.45µg/g. The overall lead concentration was detected in catla and the lowest in rohu using the ANOVA method. The concentration of lead metal at the Hartali Mod site (0.024 µg/g) for Catla catla was the highest among the other place. The order of the lead concentration in different tissue of catla was in the order brain>gills>muscles>heart>liver. The study showed that lead concentration in these fishes was under the permissible limit. Still, people should be aware of the possible threats as more lead accumulation causes serious health issues.

Keywords: *Fish, Local fish markets, Lead, Atomic Absorption Spectrophotometer, Patna*

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Introduction:

Fishes comprise a major part of the human diet due to their high protein content, low saturated fat, and sufficient omega-3 fatty acid, which are known to support good health. It consists of more protein than any other living organism, contributing approximately 75% of the weight of fish (Karthikeyan, 2012). In 2017, fish accounted for about 17 percent of total animal protein and 7 percent of all proteins consumed globally (FAO 2020). For these reasons, they are essential for national, regional, and global food security and nutritional strategies and have a significant role in eliminating hunger and malnutrition (FAO 2020). Fish and fish products are not only included among some of the healthiest food but also among some of the least impactful on the natural environment. Hence, it is cultivated and consumed in large quantities by the Indian population (Adhikari et al., 2019).

Heavy metals are among the most severe environmental pollutants due to their high toxicity, ease of accumulation due to their non-biodegradable nature, and highly persistent environment (Guevara-Riba et al.2004). They typically occur in trace amounts in the environment, but their toxicity is expressed even at lower concentrations due to their persistent and non-degradable nature. Contamination and pollution of aquatic environments with heavy metals from natural and anthropogenic sources are issues of public concern (Ambedkar and Muniyan 2011). The most common metals in fish are cadmium (Cd), lead (Pb), and mercury (Hg) (Authman et al., 2015). These heavy metals have no known essential role in living organisms; they exhibit extreme toxicity even at deficient (metal) exposure levels to all forms of life, especially human health. (Rajeshkumar et al.,2018). Cadmium and lead toxicity in humans are most often linked to long-term fish consumption (WHO 2011; Bosch et al. 2016). Fishes can accumulate heavy metals in their tissues by absorption along the gill surface and kidney, liver, and gut tract wall to higher levels than the environmental concentration (Rajeshkumar et al., 2018). Metal accumulation in different body organs of fish with varying feeding habits was extensively studied in other aquatic ecosystems (Ahmad and Al-Ghais, 1996, Hamza-Chaffai et al., 1996, Kiran et al., 2006). But, similar studies on some of the preferred fish species of Patna are scanty. The selected species *Clarias batrachus* (mangur), *Catla catla* (catla), and *Labeo rohita* (rohu) collected from local fish markets of Patna, Bihar, have good consumer preference and higher market value. The studied organs were selected for the following reasons: muscle and brain are the edible portions of fish, gill is the entry route, and the liver is the detoxifying organ for toxicants and heart, through which toxicants could be circulated to the whole body along with blood.

The objectives of the present study were i) to determine the concentration of Pb in various organs of *Clarias batrachus, Catla catla,* and *Labeo rohita* collected from local fish markets of Patna, Bihar, and ii) to assess the possible health hazards from these three fishes to its consumers.

MATERIALS AND METHOD

The fish samples were collected from four popular fish markets in Patna, namely; Raja Bazar Fish Market (25°36'17"N 85°05'07"E), Boring Road Chauraha Fish Market(25°36'47"N85°07'08"E), Hartali Mod Fish Market (25°36'20"N 85°07'01"E) and Patna City Fish Market (25°35'38"N 85°13'36"E) during March 2022. Three fish specimens from each species were purchased from the four fish markets, weighed (g) and total length measured. After that, each sample was kept separately in a sterile polyethylene bag and transported to Central Research Laboratory, Patna Women's College, Patna, in the ice box. In the laboratory, the fish samples were washed, and the brain, muscles, liver, heart, and gills were dissected with the help of surgical blades and scissors and sun-dried for 48 hours. One gram of each sun-dried sample was weighed on an electronic balance and digested with acids H_2SO_4 and HCl in a 1:1 ratio. The prepared samples were then evaluated for heavy Lead using an Atomic Absorption Spectrophotometer (SavantAA, Australia), and each organ's metal concentration was expressed as µg/g dry weight.

Statistical Analysis:

The results are presented as Mean±SD. Total variation in a data set through one-way ANOVA (Analysis of Variance). The level of significance was

taken as $p<0.05$. Different software was used in the process, such as GraphPad Prism 5, MS Excel, and MS Word.

RESULTS AND DISCUSSION

The Pb concentrations of fish organs sample of *Labeo rohita, Clarias batrachus,* and *Catla catla* collected from four fish markets in Patna, Bihar, during March 2022 are given in Table 1. The concentration of Pb varies from 0.031±0.013 µg/g in the liver to 0.002±0.002 µg/g in the heart of *Labeo rohita* from Raja Bazar fish market (Table 1). The concentration of Pb was below the detection limit in the liver, heart, and muscle of *Labeo rohita* at Patna City fish market. Pb concentration in *Clarias batrachus* varies between 0.044±0.017 µg/g in the liver (Raja Bazar fish market)to 0.005±0.004 in muscle and gills (Raja Bazar, Patna City, and Boring Road fish Market). The concentration of Pb was below the detection limit in gills at Raja Bazar and Patna City fish market and muscle at Hartali Mod fish market. Likewise, in *Catla catla,* the concentration of Pb varied between 0.042±0.015 µg/g in gills (Patna City fish market) to 0.007±0.01µg/g in the liver (Boring Road fish market). It was below the detection limit in the heart (Boring Road fish market) and muscle (Raja Bazar fish market). The lead concentration in the three species from all the four fish markets was under the permissible limits of 0.5 µg/g (Mills, 1995).

The overall accumulation pattern of Pb in *Labeo rohita*, *Clarias batrachus,* and *Catla catla* was compared at chosen study sites. In *Labeo rohita* highest concentration of Pb was seen in the Raja Bazar fish market and the lowest concentration in Patna city fish market (Fig.1).In *Clarias batrachus* highest concentration was seen in the Boring Road fish market and the lowest concentration in Patna city fish market (Fig. 2).In *Catla catla* highest concentration of Pb was seen in the Hartali mod fish market and the lowest in Boring Road fish market (Fig. 3).

The average concentration of Pb in different organs of *Labeo rohita, Clarias batrachus,* and *Catla catla* from the four studied fish markets is shown in fig. 4. Overall organ-wise lead concentration of the studied fish is shown in fig 5. The liver and brain had the highest mean lead concentration, followed by the gills, heart, and muscle (fig 5). The level of trace metals in different organs is used as an index of metal pollution in an ecosystem and an important tool to highlight the health of an organism. Higher concentrations of heavy metals were recorded in liver and gill in mullet, *Liza abu*; catfishes, *Silurus triostegus* (Karadede et al. 2004); *Wallago attu* (Aftabuddin et al. 2008). The highest degree of lead accumulation in the liver and the lowest degree of expansion in the muscle of *Labeo rohita* were also studied by Prabha and Rajkumar 2015. The liver is the primary detoxifying organ in fish, and increased metal concentration in the liver may represent the storage of metals (Aftabuddin et al. 2008). The higher Pb accumulation in gills was possible because gills were the first organ for exposure in fish to the aquatic environment (Malik *et al.* 2010). Thus, the exposure and contact with the toxicant may be the reason for more accumulation of Pb in these tissues. The difference in mean lead concentration between the organ samples was statistically significant. The significance value of the analysis was $p<0.05$.

Species-wise accumulation pattern of Pb showed the highest concentration in *Catla catla* and the lowest in *Labeo rohita* (Fig. 6). Catla had the highest mean lead concentration, followed by mangur and rohu in descending order. However, the difference in mean Pb concentrations between the three fish species was not statistically significant. Heavy metal levels in different fish species depend upon physiological requirements, feeding habits, and the habitat of a specific fish (Aftabuddin et al. 2008). *Catla catla* is a surface and mid-water feeder that is mainly omnivorous. Its juveniles feed on aquatic insects, detritus, and phytoplankton. Because of its high nutritive value, it has high demand in the market (Ilavazhahan et al., 2012). In our study, overall, the highest concentration of Pb was detected in Catla catla at Hartali Mod fish market (Fig 3 and 6).

Analyzing organ-wise accumulation of Pb showed most of the accumulation was in the gills, liver, and brain, which could be discarded. A similar result was obtained by Singh et al. (2020).

Fish is a possible mediator who can transfer nutrients to humans. Unfortunately, it may absorb heavy metals dissolved in water which may accumulate in

various tissues and organs and even be magnified in the food chain (Javed, 2003). The accumulated heavy metal poses a severe threat to humans. Hence, the studies on the accumulation of heavy metals in various fish organs are essential due to their toxic effects. Lead accumulation was different for different organs, indicating different functional capabilities to regulate metal absorption. The liver had highly accumulated Pb than muscle and gill. Prabha and Rajkumar, 2015, reported the same. The fish's liver is an essential organ for ecotoxicological study and the prime site for the accumulation of Pb (Lal Shah and Ahmet Altindau, 2005).

Fish muscle and brain consumption may pose acute and chronic health hazards to its consumers, especially humans. Therefore, fish muscle and brain safety aspects may be analyzed by comparing the concentrations of Pb with those of the WHO permissible limit. Muscle and brain Pb content of all the three fish species in the present study was detected below the permissible limit.

Aquatic organisms accumulate Pb from water and diet, although there is evidence that Pb accumulation in fish is most probably due to contaminated water rather than diet (Singh et al. 2020). The accumulation pattern varies with fish species and organs, and sampling sites.

The accumulation of heavy metals in freshwater fish is a concern for the population, taking fish as food regularly. The human population generally consumes fish muscles, and Pb concentration was below the permissible limit for all the studied fish species. Therefore, the fish is safe for human consumption, but more accumulation of Pb in the future may lead to public health risks.

Table1.Lead concentration (µg/g dry weight) in organs of fish collected from local fish markets of Patna, Bihar.

Fish/organs	Raja Bazar	Boring Road	Hartali Mod	Patna City
Labeo rohita				
Gills	0.004±0.006	0.017±0.006	0.006±0.006	0.008±0.006
Liver	0.031±0.013	0.01±0.013	0.006±0.013	nd
Heart	0.002±0.002	0.005±0.002	0.005±0.002	nd
Brain	0.004±0.003	0.007±0.003	0.008±0.003	0.010±0.003
Muscle	0.016±0.008	0.014±0.008	0.017±0.008	nd
Clarias batrachus				
Gills	nd	0.005±0.004	0.009±0.004	nd
Liver	0.044±0.010	0.02±0.010	0.026±0.010	0.028±0.010
Heart	0.009±0.006	0.016±0.006	0.006±0.006	nd
Brain	nd	0.011±0.006	0.016±0.006	0.006±0.006
Muscle	0.005±0.004	0.011±0.004	nd	0.005±0.004
Catlacatla				
Gills	0.008±0.015	0.016±0.015	0.031±0.015	0.042±0.015
Liver	0.031±0.01	0.007±0.01	0.014±0.01	0.009±0.01
Heart	0.009±0.005	nd	0.011±0.005	0.009±0.005
Brain	0.041±0.012	0.019±0.012	0.014±0.012	0.018±0.012
Muscle	nd	0.02±0.19	0.045±0.19	0.009±0.19

All the values are mean values of three replicates presented as mean±SD.

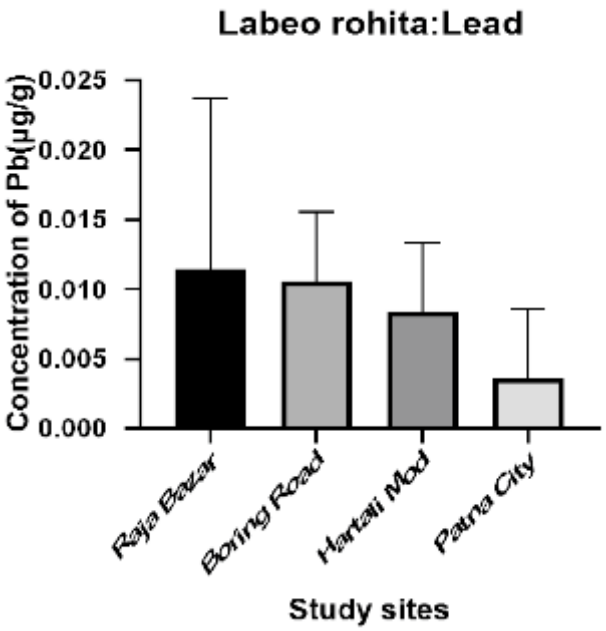

Fig. 1: Comparison of Lead concentration (in µg/g) among the samples of different sites in *Labeo rohita.*

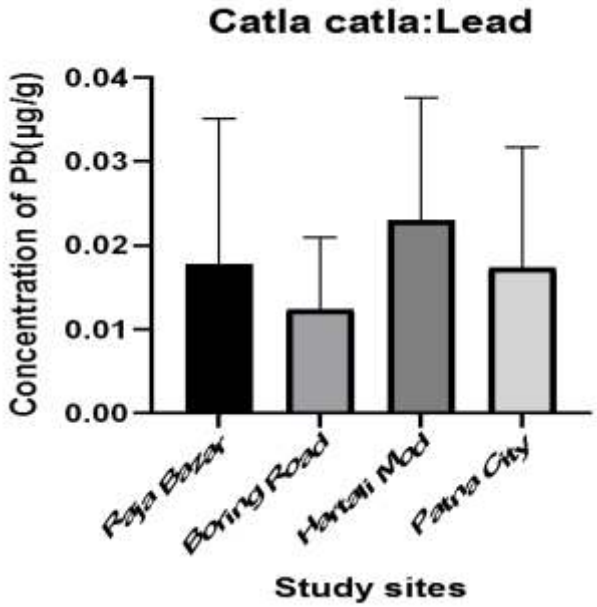

Fig. 3: Comparison of Lead concentration(µg/g) among the samples of different sites in *Catla catla.*

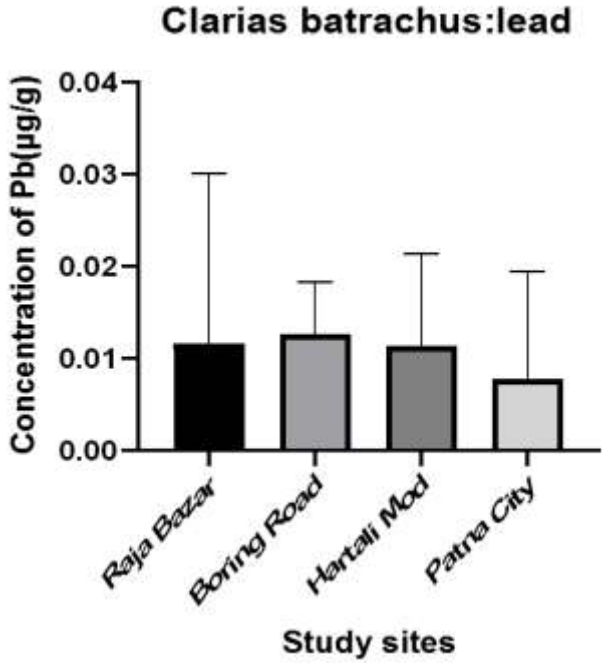

Fig. 2: Comparison of Lead concentration (in µg/g) among the samples of different sites in *Clarias batrachus.*

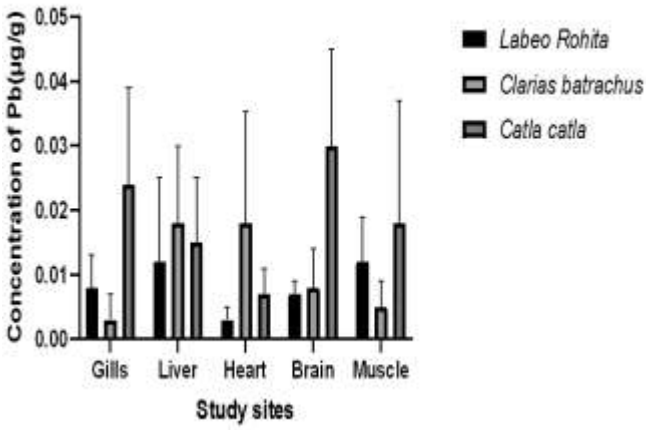

Fig. 4: Average concentration of Pb in different organs of *Labeo rohita, Clarias batrachus,* and *Catla catla* from 4 sites. Hypothesis testing method one-way analysis of variance (ANOVA)

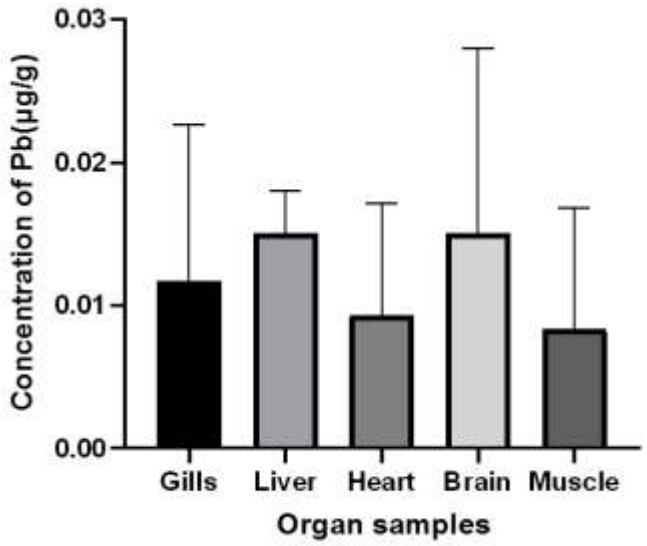

Fig.5. The average concentration of Pb(µg/g) in different organ samples of the three fish species

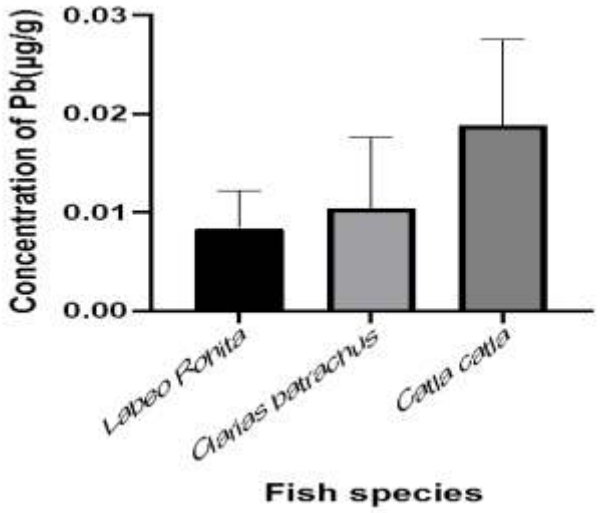

Fig 6. The overall concentration of Pb in *Labeo rohita, Clarias batrachus,* and *Catla catla* from 4 studied sites.

Conclusion

The study of lead concentration in *Labeo rohita, Clarias batrachus,* and *Catla catla* collected from four fish markets in Patna, Bihar, showed that lead concentration in these fishes was under the permissible limit. Still, people should be aware of the possible threats shortly as more accumulation of lead causes serious health issues. The maximum accumulation was found in the liver and brain (*Clarias batrachus*), which could be avoided for consumption.

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