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Evaluation of heavy metals accumulation in selected food fish *Mystus cavasius* from river Krishna, Andhra Pradesh

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Abstract
Heavy metal accumulation has become a serious threat to the present century, particularly in fish and fishery products. These metals are dangerous are impact on aquatic fauna and it can be bio accumulated in the organisms through food chain. It leads to very chronic and complicated problems in the human beings. Cumulative properties of metals and prolonged poisoning may result very complicated problems even low concentrations. The river Krishna is one of the largest domestic water covers area of about 2,58,948 sq km and spread is across the four southern states Maharashtra, Karnataka, Telangana and Andhra Pradesh. The heavy metals that get enter into water channel because the fly ash tanks of the VTPS are not properly lined and they end up contaminating the surface water is released into sumps which intern discharges into the drainage canal. The discharge canal has a length of about 1.9 km and discharges polluted water into river Krishna at 0.4 km downstream from the shores of Ibrahimpatnam. The average concentrations of Ni, Cd, and Pb were below the permissible limits and Zn and Cu are slightly higher of established by WHO. Potential human health risks were evaluated in river Krishna by measuring the estimated daily intake (EDI) and target hazard quotient (THQ). Therefore, this baseline data would help to adopt strategies in control measures and protect the fragile river environment.

Keywords: Heavy metals, VTPS Pollution, *Mystus cavasius* and health risk assessment

Introduction

India is equipped with a network of rivers, reservoirs, lakes, ponds, streams, and canals, making it rich in water resources. The country's population is growing quickly, and there is a need to fulfil the rising demand for human needs, therefore many areas of the country may not have enough water resources [1]. Small rivers and streams are routinely discharged with agricultural, industrial, and domestic effluents that contain a variety of organic and inorganic contaminants, including solvents, heavy metals, pesticides, oils, and fertilizers, etc. Heavy metal pollution of the aquatic environment may come from industrial waste [2].

Recent studies [3, 4] on the origins, transport, toxicity, mode of action, and bioaccumulation of heavy metals in the food chain and in species in rivers and estuary environments. According to Burakov *et al.* [5], domestic garbage, agriculture, aquaculture, and the combustion of coal and fuel oil all release metals into coastal and marine waters through rivers and creeks. Metals frequently adhere to the surfaces of particles in water columns and settle into the sediment [6]. Aquatic species' tissues can acquire metals from the water and sediment [7]. Numerous studies [6, 8, 9, 10] have shown that metal contamination in water, sediments, and fish bioaccumulation in river systems along the Indian coast [9, 11, 12 and 13]. In particular in rivers and reservoirs, anthropogenic activity in the aquatic environment causes exceedingly complex issues. Considering that released toxins frequently end up in the river ecosystem, it is important to identify and assess the possible dangers to exposed aquatic biota [14]. Environmental risk assessment requires monitoring procedures for both water and chemicals to measure contamination levels [3, 4, 15, 16].

The Krishna river has a length of nearly 700 miles from its origin in the 4,000-5000 feet high western - ghat ranges south of Poona, as far as Vijayawada almost at sea-level near its delta on the East-Coast [6]. The catchments of the Krishna system is 90,050sq.miles, consisting of thick forests in the hilly region of the Western-Ghats with over 300inches of rainfall in some pockets, and intensely cultivated open field in the dry, middle plains [17]. The catfish species *Mystus cavasius* is a member of the Bagridae family of order Siluriformes. It is frequently referred to as Gangetic Mystus and has reportedly been distributed in Myanmar, Bangladesh, Pakistan, Sri Lanka, India, Bangladesh, and Sri Lanka [18]. The fish is typically found in fresh water and can be found in rivers (both fast and slow flowing), canals, beels, ponds, ditches, and inundated fields [19]. Tidal rivers and lakes have also been recorded to include the fish [20]. It has a high market price and a strong market demand as a food fish [18, 20]. This fish has recently been reported to be exported from India as an indigenous ornamental fish due to high demand [21].

Keeping the view of the importance of metals the main purpose of present study deals with the status of heavy metals in *Mystus cavasius* and health risks of Fish consumers of river Krishna near Ibrahimpatnam are studied.

Materials and methods

Fish samples were taken from the Ibrahimpatanam between July 2021 and June 2022, throughout various months. The fish samples are brought to the lab in ice trays and kept there at -10°C for upcoming examination. With the use of a rust-free stainless steel kit, the fish *Mystus cavasius* was dissected. 25% of the muscle were utilized as blank samples to accompany each run of the study using the Atomic Absorption Spectrophotometer (ASS). The muscles were separated, dried to a constant weight, and both wet and dry weight was recorded. To assure precision and accuracy for the analytical process, each sample underwent three separate analyses.

Health risk assessment

Estimated daily intake (EDI):

$$EDI = \frac{E_F \times E_D \times F_{IR} \times C_f \times C_m}{W_{AB} \times T_A} \times 10^{-3}$$

E_D = The exposure duration, equality to average life time (65 years)

E_F = The exposure frequency 365 days/year

F_{IR}= The fresh food ingestion rate (g/person/day) which is considered to be India 55/g/person/day (Mitra *et al.*) [22].

C_f = The conversion factor = 0.208

C_m = The heavy metal concentration in food stuffs mg/kg d-w)

TA = Is the average exposure of time for non carciniges (It is equal to ($E_F \times E_D$) as used by in many previews studies (Wang *et al.* [23])

$W_{AB=}$ average body weight (bw) (average body weight to be 60kg)

Target hazard quatent

THQ = EDI / RfD

Rfd - Oral reference dose (mg/kg bw/day)

THQ levels above 1 indicate that there is a chance of non-carcinogenic consequences, which become more likely as the value rises, whereas THQ values below 1 indicate that the exposed population is unlikely to incur overtly negative impacts.

Results and Discussion

This research's goal was to find out whether certain metals were present in the Krishna River's *Mystus cavasius*. Both THQ values and the mean concentration of heavy metals in fish muscle are shown in Table No. 1 and Fig. 1, respectively. Zn was the most prevalent heavy metal in fish, followed by Cu, Ni, Cd, and Pb (i.e. Zn>Cu>Ni>Cd>Pb)

Zinc

A crucial trace metal for metabolic activities is zinc. A potential risk to humans arises from an excess of quantity in an animal's diet [24]. Chronically consuming too much zinc through food can result in iron and copper deficiencies, nausea, vomiting, fever, headache, fatigue, and stomach pain. In India, a daily consumption of 16.1mg of zinc is advised [25]. It is not poisonous, although 25 mg/l has been proven to have some negative consequences [26]. The degree of toxicity of zinc depends on the health of the fish and the water [27]. According to the current study, typical muscle Zn concentrations range from 7.0 to 8.5 mg/kg, which is lower than WHO requirements [28].

Copper

Due to its necessity in numerous enzymatic processes, copper (Cu) is a vital trace element [29]. Large amounts of copper sulfate deliberately consumed have been known to cause human fatalities. A safe limit for Cu concentration was established by a different regulatory agency [3]. For example, the FAO established a permitted maximum of 30 mg/g based on wet weight. Although it is thought to be necessary for optimal health, excessive consumption can have negative health effects, including damage to the liver, kidneys, and other important organs [14, 30]. It is essential for the production of haemoglobin and is a component of various enzymes [16]. Cu is needed for biological electron transport in the enzymes cytochrome c oxidase and superoxide dismutase [31]. The present study mean concentrations of different seasons were ranged 5.3 to 6.3 mg/kg in the muscle of *M. cavasius*.

Nickel

Silvery-white nickel is a strong, malleable, and elastic metal. It is a ubiquitous trace metal that can be found in the biosphere, water, air, and soil. Living things just need a tiny amount of it [32]. Animals are not known to accumulate nickel. Nickel does not bio magnify up the food chain as a result [33]. Nickel is more mobile than other heavy metals once it has been discharged into the environment [34]. Nickel is necessary in small amounts, but when the maximum tolerable amount is surpassed, it can be harmful to human health in terms of sickness, vertigo, and birth defects [33]. The average Ni content in the current study varied from 3.2 to 4.8 mg/kg over the several seasons.

Cadmium

Cadmium has been associated with various health problems including kidney dysfunction, skeletal damage and reproductive deficiencies [15]. As a non-degradable cumulative pollutant like Cd is considered capable of altering aquatic tropic levels for a long time [35, 36, 37]. Cadmium is widely distributed at low levels in the environment and is not an essential element for humans [38]. In the present study, the average values 4 season the Cd shows 3.2 to 4.9 mg/kg in the muscle. Cadmium is a nonessential element that causes severe toxic effects even at low concentrations. Its accumulation in the human body may leads to the occurrence of renal, pulmonary, hepatic, skeletal, reproductive effects and even cancer [39].

Lead
When swallowed or inhaled in large quantities, the hazardous metal lead can have an impact on people. In addition to increasing mucous production in fish, it can also result in decreases in survival, growth rates, development, and metabolism [14]. Children's cognitive development and intellectual performance are known to suffer, while adults' blood pressure and cardiovascular illness are known to rise. Lead is a trace metal that is not necessary, and its harmful effects on health are well-known. In the current investigation, the Pb content in the muscle of *M. cavasius* ranges from 3.2 to 3.6 mg/kg depending on the average values of the various seasons. The maximum allowable amount for eating fish is 2mg/kg, according to WHO [28]. The present results indicated that the concentration levels of Pb was little bit higher than the permissible limits.
The bioavailability of the metals depends in a section on the convergence of anions and chelating present in the adsorptive drugs. Metals like Zn, Cu and Ni are fundamental metals since they assume significant part in the natural framework, whereas lead and cadmium are poisonous even in minimum levels [14]. The metals can deliver harmful effects at high focuses. Weighty metal focus is an especially critical in ecotoxicology since these metals are profoundly continue and can bio accumulate and bio magnify in the natural pecking order, subsequently becoming poisonous to living creatures at higher jungle levels. Substantial metal fixation, especially lead and cadmium can adversely affect the natural ecosystems.

Conclusion
Fish is a major source of food for human beings and the potential health risks associated with the fish consumers might be linked to the carcinogenic effects. The daily and weekly intakes were calculated in order to determine the extent of exposure through fish consumers.
The WHO have set limits for heavy metals levels in fish products and above that limits it is unsuitable for human consumption. Finally, we recommended that a long-term continuous monitoring is essential and to check metals level, in order to reduce of metal levels in fishes in Krishna River. From the point of view of human health risk, the THQ values of heavy metals are less than 1, indicating no health risks to consumers. However, the average THQ values of the current investigation showed that Zn and Cu are somewhat higher than those set by the World Health Organization, whereas Ni, Cd, and Pb were below the permitted limits.

Table 1: The average heavy metals concentration (mg/kg dry weight) in muscle of *Mystus cavasius* collected from river Krishna

Metals	South West Monsoon	Post Monsoon	North East Monsoon	Summer
Zinc	8.5±2.4	7.6±2.1	7.5±2.2	7.0±2.1
Copper	6.3±1.2	6.1±1.1	5.4±1.0	5.3±1.2
Nickel	4.8±1.2	4.9±1.3	3.9±0.7	3.2±0.5
Lead	3.6±0.5	3.5±0.5	3.2±0.4	3.3±0.5
Cadmium	4.35±1.3	3.8±1.2	3.9±1.2	4.2±1.4

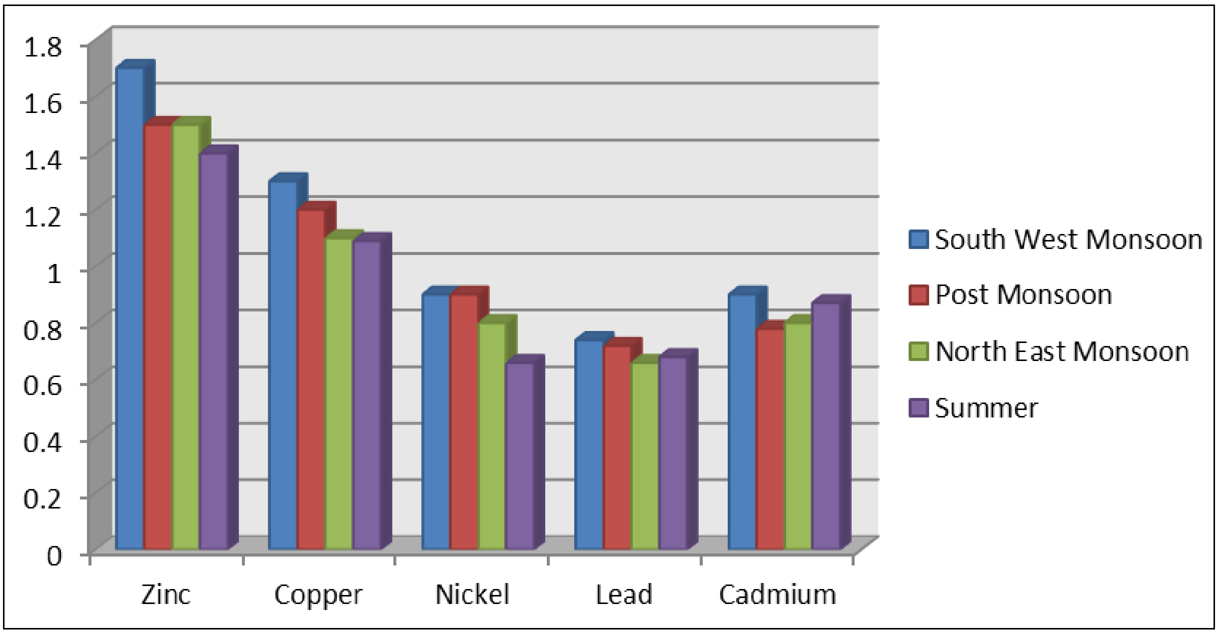

Fig 1: THQ values of muscle in *Mystus cavasius* collected from river Krishna

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