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ASSESSMENT OF HEAVY METALS IN SEDIMENTS OF FISH CULTURE PONDS AT BHADRA FISH FARM, KARNATAKA

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Abstract:

In this study, an attempt has been made to evaluate heavy metals such as Fe, Mn, Zn and Cu in the fish pond sediments at Bhadra fish seed farm, Karnataka from six ponds at monthly intervals for a period of six months from March to August 2007. The results of the analysis showed that heavy metals in the fish pond sediments are well within the Geo accumulation index standards except copper which is uncontaminated to moderate as per Geo accumulation index values.

Key Words: Heavy Metals, Bhadra Fish Farm, Pond Sediments & Geo-Accumulation Index

Introduction:

Water is very precious for every living organism on this earth. The available fresh water to man is hardly 0.3 to 0.5% of the total water available on the earth and therefore its judicious use is imperative. In today's scenario, unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals cause of heavy and varied pollution in aquatic environments leading to deterioration of water quality and depletion of aquatic fauna including fish. Without the knowledge of water chemistry, it is difficult to understand the biological phenomenon fully, because the chemistry of water reveals much about metabolism of the ecosystem and explains the general hydro-biological interrelationship (Deshmukh and Ambore, 2006; Patil, R. Anil, and. Lohar Prakash, 2009).

Heavy metal toxicity has grown up as a serious concern all over the globe as these heavy metals pose adverse effects on all forms of living organisms in the biosphere. Biomagnification of heavy metals along the food chains occurs leading to various health hazards to both humans and other living organisms. Heavy metals affect the structural, biological functioning of biomolecules (McCormick et al., 2005). Heavy metals are also known to interfere with synthesis and metabolism of the hormones (Manjappa and Puttaiah, 2005; Riddell et al., 2005; Gupta et al., 2009).

Occurrence of elevated level of trace metals especially in the sediments can be a good indication of man-induced pollution and high level of heavy metals can often be attributed to anthropogenic influences rather than natural enrichment of the sediment by geological weathering (Davies et al., 1991). Sediments have the tendency to become the sink component for accumulation of heavy metals and consequently may adversely affect benthic organisms. In the long-term, the contaminated sediments could be a second source of pollution of the overlying water when the environmental conditions to which the sediment is exposed are altered (Nriagu, 1988).

Materials and Methods:

The present study was carried out for a period of six months from March 2007 to August 2007. Six fish culture ponds were selected for sediment analysis at Bhadra fish seed farm, Karnataka.

The sampling, preservation, digestion and preparations of samples for the analysis of heavy metals in the sediments were made as prescribed by Standard Methods of APHA (1995) using Atomic Absorption Spectrophotometer (GBC Avanta Version 1.31).

Geo Accumulation Index (Igeo):

Geo-accumulation indexing approach, Igeo is used to quantify the degree of anthropogenic contamination and compare different metals that appear in different ranges of concentration in the sludge (Muller 1969; Sapana Gupta et al., 2014).

$$Igeo = \ln (Cn/1.5 \times Bn) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where Cn= measured concentration, µg/g and Bn = geochemical background value, µg/g. In eqn. 1, average values were used and 1.5 is the factor used for lithologic variations of trace elements. The geo-accumulation index compares the measured concentration of the element in the fine-grained sludge fraction Cn with the geochemical background value Bn. Average values of soil samples of the study region (which is taken as reference point) are considered as Bn values. The index of geo-accumulation consists of seven grades, whereby the highest grade reflects 100-fold enrichment above background values (Praveena et al., 2008; Sapana Gupta et al., 2014). Forstner et al (1993) listed geo-accumulation classes and the corresponding contamination intensity for different indices Table 1.

Results and Discussion:

Table-1 depicted heavy metal levels (µg/g) in sediment samples. Table-2 also shows Geo accumulation index classification and Table-3 shows Geo accumulation indices of heavy metals in fish culture pond sediments.

Zinc is an important trace element and plays a vital role in the physiological and metabolic processes of many organisms. At higher concentration, it can be toxic to organisms and plays an important role in protein synthesis (Prask and Ploeke. 1971). Zinc-is transported mostly in residual, exchangeable and carbonate fraction of sediments (Chakrapani and Subramanian, 1993; Manjappa & Puttaiah, 2005). In the present study, zinc content ranged from 13 to 168 µg/g (Table 1). The concentration of zinc was maximum at pond 3 and minimum in pond 6.

Copper is highly toxic trace metal posing a great threat to aquatic organisms if present in a level higher than the maximum acceptable toxicant concentration. There is no indication that copper is carcinogenic to humans (Moore and Ramamoorthy. 1984; Manjappa & Puttaiah, 2005). The results of present study revealed that copper content ranged between 3.0 and 45.0 µg/g (Table 1). The maximum concentration was noticed at pond 3.

Iron is an essential element and is known to be a limiting nutrient factor in fresh water ecosystem (Duce and Tindale, 1991). The iron content presents in the sediments primarily as a hydrated oxide and is a part of lithogenic material and thus less mobile. During weathering process iron might also form as ferric oxide coating on clay minerals (Culvert, 1976; Manjappa & Puttaiah, 2005). In the present study, iron content ranged between 205.0 and 893.0 µg/g. The maximum concentration was recorded at pond 3 and minimum at pond 1.

The manganese is an essential element, which does not occur naturally as a metal but is found in various salts and minerals frequently associate with iron compounds. The exchangeable and residual fractions are in dominant phase for manganese in suspended and bed sediments respectively (Chakrapani and Subramanian, 1993). Manganese content varied from 10.0 to174 µg/g.

Conclusion:

Based on the data obtained, it can be concluded that the concentration of heavy metals in fish pond sediments found to be lower in all the ponds except copper which is uncontaminated to moderate as per Geo accumulation index values.

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Table 1: Heavy metal levels (µg/g) in fish pond sediment samples

Pond No	Zinc	Copper	Manganese	Iron
1	48	3	22	205
2	31	5	12	498
3	168	45	174	893
4	32	6	32	615
5	14	3	14	412
6	13	4	10	514

Table 2: Geo accumulation index classification (Forstner et al., 1993)

Sediment Geo Accumulation Index	Igeo Class	Contamination Intensity
> 5	06	Very strong
> 4-5	05	Strong to very strong
> 3-4	04	Strong
> 2-3	03	Moderate to strong
> 1-2	02	Moderate
> 0-1	01	Uncontaminate to moderate
<0	00	Practically uncontaminated

Table 3: Geo accumulation indices of heavy metals in Fish culture pond sediments

Metal	Index of Geo Accumulation Igeo	Sediment Quality
Fe	<0	Practically uncontaminated
Zn	<0	Practically uncontaminated
Cu	0.1	Uncontaminate to moderate
Mn	<0	Practically uncontaminated