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HEAVY METAL CONTENT IN WATER AND SEDIMENT OF SHRIMP FARMS OF SATKHIRA, BANGLADESH

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Abstract
Toxic contaminants moving along with runoff usually contaminates shrimp farms in most areas of Satkhira district, southwest Bangladesh. An investigation was carried out to assess the Physico-chemical properties and heavy metal concentration of sediments and water in shrimp farms from Satkhira district, southwest Bangladesh during December 2020 to March 2021. Twelve water and sediment samples were collected from six *Ghers* of two Upazilla e.g., Debhata and Assasuni of Satkhira. Physico-chemical attributes such as temperature, DO, BOD_5, pH, TDS, EC, turbidity, salinity, HCO_3^-/CO_3^-, SO_4^-, NO_3^-, PO_4^- were estimated. The concentration attributes such as TDS (2280-5250 mg/l), EC (4380-9670 µs/cm), Turbidity (50.8-348 NTU), HCO_3^-/CO_3^- (219.6-445.3 mg/l), NO_3^- (0.3635-1.94 mg/l) were observed to be higher than the allowable standards recommended by WHO and FAO. Five trace metals such as chromium (Cr), cadmium (Cd) copper (Cu), lead (Pb) and Zinc (Zn), were measured in sediments and water by Atomic Absorption Spectrometer. The range of metal concentrations in sediment were as follows: Cr (1.95–3.43 mg/l), Zn (205.76-265.71 mg/kg), Cu (0.60–1.1mg/kg), Cd (3.8-4.1 mg/kg), and Pb (0.92-1.11mg/kg wet weight. The range of metal concentration in water were as follows: Cr (0.1-0.8 mg/l), Zn (0.003-0.34 mg/l), Cu (0.10-0.13 mg/l), Cd (0.07-0.08 mg/l), and Pb (0.23-0.34 mg/l). Higher concentrations of metal were recorded in most of the sediment and samples of water of the studied *Ghers* except Cr and Cu, those were below standard as prescribed by WHO and FAO. The concentration of Cu ranges from 0.602 to 1.113 mg/kg and 0.10 to 0.13 mg/l and range of Cr concentration were 1.95 to 3.43 mg/kg and 0.156 to 0.807 mg/l in sediment and water respectively. However, Cd, Zn and Pb were higher than the allowable standard as recommended by WHO and FAO. The higher heavy metal concentrations in water and sediment of shrimp *Ghers* suggest that shrimp could be contaminated by these heavy metals as well.

Keywords: Contamination, Heavy metal, Sediments, *Gher* water, Satkhira

Introduction

Due to their toxicity, persistence, and bio - accumulative characteristics, heavy metals are typically considered to be environmentally dangerous. "Naturally occurring metals with an atomic number greater than 20 and an elemental density greater than 5 $g.cm^{-3}$" are categorized as heavy metals (Khan and Ali 2018). They come from varieties natural and anthropogenic sources that release them into the environment. Agricultural runoff, residential sewage, and industrial effluents are examples of anthropogenic sources of heavy metal pollution. Industries degrade ecosystems and the environment by releasing pollutants into the air and water. (Bangash and Alam 2004). Metal contamination today poses a threat to almost every area of the aquatic environment, and its impacts are inevitable. The current situation of global water contamination is mostly caused by the expansion of industrialization, expansion of urbanization, and population boom (Tchounwou et al. 2012).

Toxic heavy metals have become more transportable in the environment and their biogeochemical cycles have changed as a result of industrialization and rapid economic development. Various human activities have made

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freshwater ecosystems, such as rivers, lakes, and streams susceptible to heavy metal pollution. A significant environmental problem is the toxic heavy metal contamination of freshwater ecosystems and as a consequence of aquatic species like fishes accumulate relatively high levels of heavy metals because of their high trophic position in food webs (Siraj et al. 2014). Human health is significantly impacted by the trophic transmission of potentially hazardous heavy metals in human food chains, particularly in fish. The Minamata disease, which was driven by consuming Hg-contaminated fish in Japan, is a well-known case. A significant environmental chemical disaster of the previous century was the development of Minamata disease in Japan in the 1950s (Ali and Khan 2017).

These metals are non-biodegradable, so they accumulate in environmental components like water and sediment before moving easily into living systems like fish and shellfish and participating in bioaccumulation and biomagnification, which is prevalent in the aquatic food web and ultimately causes of disorders of various biochemical in humans and other animals (Zhao et al. 2012, Olmedo et al. 2013, Kumar et al. 2015, Dadar et al. 2016, Dhanakumar et al. 2015, Duruibe et al. 2007).

As freshwater fish play a significant role in the human food chain, it is crucial to routinely examine them for heavy metal pollution (Ali et al. 2017). Through the gills, skin, and stomach of the fish, heavy metals may enter the body either directly from the abiotic environment (ambient water and sediments) or indirectly from the fish's diet or prey. Because they are directly exposed to the outside environment, fish gills are vulnerable to contaminants in the ambient environment (Waheed et al. 2014). Heavy metals and other chemical pollutants, particularly those caused by industrial and agricultural expansion and urbanization, are constantly released into rivers. Plants, animals, and people may all be affected by heavy metals. They function as metabolic toxins (Csuros et al. 2002).

Due to their toxicity, longterm persistence, bioaccumulation, and biomagnification in the food chain of ecosystems, metals of natural and anthropogenic sources may represent a severe hazard (Papagiannis et al. 2004). Therefore, residues of heavy metal in polluted ecosystems can build up in bacteria, fish, and aquatic animals, which could enter the food chain of human and create health hazards (Gupta et al. 2009). The heavy metals quantity in fish and crustaceans along the northern Bay of Bengal shoreline has apparently enlarged and posing a threat to human health (Borrell et al. 2016).

In Bangladesh, the second-largest export material is shrimp due to its high commercial importance, tiger shrimp are referred to as the country's "white gold" (Ahmed and Diana 2015). In Bangladesh, the coastal areas particularly Bagerhat, Khulna, Satkhira, Chittagong, Cox's Bazar and other districts, are where shrimp are primarily raised (Matin et al. 2016). Heavy metals are more harmfull to crustaceans (Ahsanullah et al. 1981). Baki et al. (2018) recorded the levels of heavy contamination of As, Cd, Cr, Cu, Fe, Hg, Mn, Pb and Zn in six most consumed fish, a lobster, three crabs, a *P.sculptilis* shrimp, and other crustaceans taken from the Saint Martin's Island, Bangladesh. In aquatic ecosystems, such as water, sediments, fish, and shrimp, heavy metals may accumulate. These are subsequently absorbed into the human body via the food chain. (Yohannes et al. 2013 and Maceda-Veiga et al. 2013) Increased concentrations of heavy metals including Pb, Cd, and Cr in shrimp could be dangerous for human health. However, heavy metal pollution in shrimp has grown to be a significant global concern due to both the damage it poses to shrimp and the non-cancerogenic health hazards associated with shrimp eating. For instance, the presence of lead in food may result in renal failure and liver damage (Lee et al. 2011). Long-term lead exposure can cause comas, mental impairment, and even death (Al-Busaidi et al. 2011). Cadmium damages the kidneys and causes chronic toxicity symptoms such as tumors, hepatic dysfunction, infertility, hypertension, and reduced renal function (Rahman et al. 2013). Similarly, Chromium could destroy proteins and membrane lipids, hence disturb cellular integrity and activities. (O'Brien et al., 2001; Mattia et al., 2004)

One of the major shrimp-farming regions in Bangladesh's south-west is Satkhira. Studies on the physico-chemical characteristics of this location as well as the concentration of heavy metals in water and sediment have been conducted in very small numbers. Regarding the assessment of heavy metal concentrations in water and sediment, there is still a dearth of knowledge. The physico-chemical characteristics of the water and the level of heavy metal in the surrounding sediments and water have become valuable knowledge in this context. It is possible that the results will increase public knowledge of the safety of consuming shrimp and other *Gher* fish, which absorb heavy metal from water and sediments.

Materials and Methods

Study Area

In the south-west region of Bangladesh, Satkhira is an important shrimp farming location. The majority of Satkhira's residents work in agriculture, fishing, and shirmp farming. The study is conducted in six different *Gher* situated in Satkhira District, Bangladesh (Figure 1); which were selected randomly to carry out the present study.

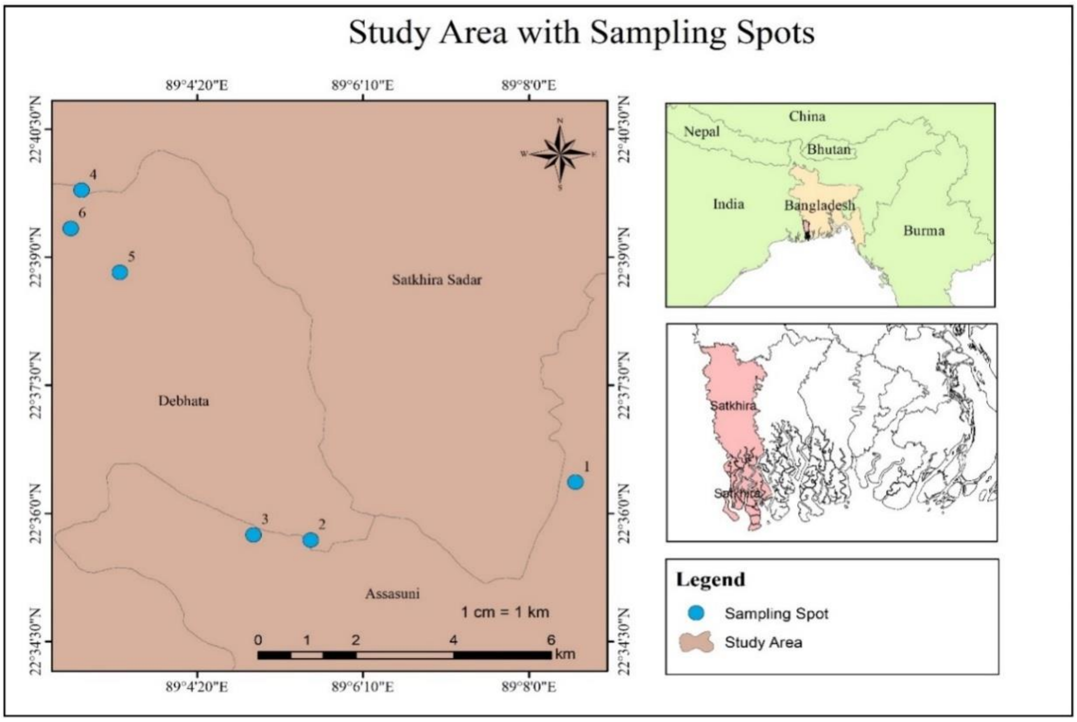

Figure 1. Study location with the sampling sites

Water and sediment collection

Using 1000 mL bottles labeled with a code number and the sampling date, water samples were taken from six shrimp culture ponds (*Gher*) at various locations. Water samples were stored in a plastic bottle containing 1% HNO_3 for the purpose of determining the presence of metal ions, and they were transported from the field to the lab using an ice box. Similar to this, from December 2020 to March 2021, six sediment samples were taken from the bottom sediment of particular shrimp farms (*Gher*) at a depth of 0–15 cm. To keep the collected sediment samples moist, they were stored in zip-top bags.

Water and sediment analysis

Physico-chemical attributes such as temperature, DO, BOD_5, pH, TDS, EC, turbidity, salinity, HCO_3^-/CO_3^-, SO_4^-, NO_3^-, PO_4^- were estimated (APHA,1998). In 100 ml plastic bottles that had been washed with diluted hydrochloric acid and then filled with distilled water, then water samples were collected. All bottles were transported to the lab following the collection of wetland water samples. To separate unwanted suspended and solid contaminants, filter paper (Whatman No. 1) was used to filter the water samples. The next step was to transfer 6 water samples to new 100 ml glass bottles that contained 10 ml of 2M HCl. To prevent air exposure, all bottles of the 100 ml solution were promptly sealed. Each sample taken in a plastic bottle was labeled independently with a unique identification number in order to provide the necessary information for each sample, such as the date of collection, location, sources of water, etc.

The amount of metal that dissolves in water after passing through a 0.45 m filter is included. The fresh samples were collected and rapidly filtered by using a membrane filter (0.45 m) in Millipore Filtration Assembly. Prior to use, 1:1 HNO_3 acid solution was used to wash the Millipore Filtration Assembly. The solution was then accurately measured (10–20 ml) and thoroughly mixed before being placed in a beaker or conical flask. After placing boiling chips on a hot plate, 5 ml of concentrated HNO_3 was added and vigorously heated until the amount reached 10 to 20 ml. HNO_3 was added and the boiling process was repeated until the solution was clear or light in color. After cooling, the volume was increased to the appropriate level (Ali et al. 2012). Ready samples were analysis through Atomic Absorption Spectrophotometry, the recorded value was calculated as follows:

Concentration of metal in sample (ppm) = Observed concentration (ppm)× Concentration factor

After drying the sediments, the samples were grinding and sieved. 1.0 g sediment sample was taken in the digestion vessel, and 5 ml HNO_3 and 3 ml $HClO_4$ were added. After that digestion vessel placed on a heating block and heated at 120 ^{o}C temperature (two hours) and 180 ^{o}C (one hour). Digested cooled sample was filtered and diluted to 50 ml with distiled water in a plastic bottle. Another 1g sediment sample was mixed with 17 ml Triacid mixture (14 ml HNO_3:2ml $HClO_4$:1 ml H_2SO_4) and placed in a digestion tube; it was heated at 150^{o} C for 2 hours. Digested sample (colorless or faint color) was filtered and washed with 2% HNO_3 solution and made it 50 ml volume. (Ali et al. 2012). The concentration was calculated as follows:

$$\text{Concentration of metal (ppm)} = \frac{\text{Concentration observed (ppm)} \times \text{Final volume(ml)}}{\text{Sediment weight(g)}}$$

Results and discussion

Concentrations of Pb, Cu, Zn, Cd and Cr in samples of water and sediment collected from the selected *Ghers* under study are summarized in Table 1 and Table 2. The Concentration of Cu and Zn in water were negligible (0.107±0.002 to 0.137±0.006 mg/l) and (0.232±0.006 to 0.345±0.009mg/l) in all localities while concentration of Pb, Cd, Cr were very high (0.232±0.006 to 0.345±0.009 mg/l), (0.0723±.0007 mg/l to 0.0885±.0005 mg/l) and (0.15±0.091 to 0.807±0.006 mg/l) in water in most of the sampling stations.

Table 1. Heavy metal conditions of the waterbodies of *Gher*

Sampling Spot	Heavy Metal Concentration in Water (mg/l)				
	Lead (Pd)	Copper (Cu)	Zinc (Zn)	Cadmium (Cd)	Chromium (Cr)
Gher 1	0.235±0.003	0.137±0.006	0.0056±0.006	0.0809±.0009	0.314±0.007
Gher 2	0.262±0.005	0.128±0.009	0.0065±0.007	0.0853±.0006	0.15±0.091
Gher 3	0.257±0.003	0.119±0.007	0.0033±0.003	0.0777±.0004	0.561±0.006
Gher 4	0.29±0.006	0.118±0.009	0.3466±0.347	0.0723±.0007	0.807±0.006
Gher 5	0.345±0.009	0.107±0.002	0.0121±0.012	0.0858±.0008	0.167±0.003
Gher 6	0.232±0.006	0.123±0.006	0.0042±0.004	0.0885±.0005	0.357±0.007
Maximum	0.345±0.009	0.137±0.006	0.3466±0.347	0.0885±.0005	0.807±0.006
Minimum	0.232±0.006	0.107±0.002	0.0033±0.003	0.0723±.0007	0.15±0.091
FAO/WHO Standard	0.01	2	5	0.01	0.05

Svobodová and Vykusová (1993) recorded that, the highest admissible copper concentration was in the water from 0.001 to 0.01 mg/l depends on the fish species and physico-chemical condition of water. Present study founded that highest value for Cu concentration was found 0.137 mg/l in *Gher*-1 and the lowest concentration value was found 0.107 mg/l in *Gher*-5. WHO and FAO recommended a permissible limit for Cu concentration in water for shrimp farming, which is 2 mg/l. Cu content of the selected six shrimp *Gher*was lower than the maximum permissible concentration limit. Guhathakurta and Kaviraj (2000) documented that, Zn concentration of the selected six shrimp *Gher* was lower than the maximum allowable concentration limit. The concentration of Zn in water ranged from 0.21–13.6 µgm.L^{-1}. Present study founded that the highest concentration value was found 0.346 mg/l in *Gher*-4 and the lowest concentration were found 0.232 mg/l in *Gher*-3. WHO and FAO recommended a permissible limit for Zn concentration in water for shrimp farming, which is 5 mg/l. Guhathakurta and Kaviraj (2000) studied that, Concentrations of Cd in water was negligible which range is 0.03-0.08 µgmL^{-1} in all the localities.

Present study founded that the highest concentration value was found 0.346 mg/l in *Gher*-6 and the lowest concentration value was found 0.0723±.0007 mg/l in *Gher*-4. WHO and FAO recommended a permissible limit for Cd concentration in water for shrimp farming, which is 0.01 mg/l. Cd concentration of the selected six shrimp *Gher* was always higher than the maximum permisible concentration. WHO and FAO recommended a permissible limit for Pb and Cr concentration in water for shrimp farming, which is 0.01 mg/l and 0.05 mg/l. The concentration Pb and Cr of the selected six shrimp *Gher* was higher than the maximum allowable concentration limit.

The Concentration of Cu and Cr in sediment were negligible (0.602±0.04 to 1.176±0.04 mg/kg) and (1.957±0.09 to 3.433±0.09 mg/kg) in all localities while concentration of Pb, Cd, Zn were very high (0.921 ± 0.10 to 1.113 ± 0.11 mg/kg), (3.805±0.08 to 4.10±0.07 mg/kg) and (205.76±1.14 to 265.716±2.29 mg/kg) in sediment in most of the sampling stations.

Table 2. Heavy metal conditions of the sediment of *Gher*

Sampling Spot	Heavy Metal Concentration in Sediment (mgkg^{-1})				
	Lead (Pd)	Copper (Cu)	Zinc (Zn)	Cadmium (Cd)	Chromium (Cr)
Gher 1	0.921 ± 0.10	1.030±0.05	205.76±1.14	4.045±0.01	1.957±0.09
Gher 2	1.113 ± 0.11	1.054±0.06	265.716±2.29	3.805±0.08	2.368±0.15
Gher 3	1.031 ± 0.06	0.905±0.03	224.16±1.01	3.885±0.10	2.87±0.07
Gher 4	1.004±0.06	0.801±0.02	223.51±0.90	4.155±0.08	3.316±0.16
Gher 5	0.976±0.07	1.176±0.04	230.8±0.91	3.887±0.10	3.271±0.04
Gher 6	1.058±0.05	0.602±0.04	240.235±2.99	4.10±0.07	3.433±0.09
Maximum	1.113 ± 0.11	1.176±0.04	265.716±2.29	4.10±0.07	3.433±0.09
Minimum	0.921 ± 0.10	0.602±0.04	205.76±1.14	3.805±0.08	1.957±0.09
FAO/WHO Standard	0.3	40	40	0.2	5

Himadri and Kaviraj (2000) recorded that the range of Cu concentration in sediment was 15.02 to 205.236 µg.g-1. Present study founded that the highest concentration was found 1.176 mg/kg in Gher-5 and the lowest concentration were found 0.602 in Gher-6. WHO and FAO recommended a permissible limit for Cu concentration in water for shrimp farming, which is 40 mg/kg. Cu concentration of the selected six shrimp Gher was lower than the maximum allowable concentration limit. Swarna Das et al. (2017) reported that, the highest mean concentration of Chromium (Cr) in sediment was 9.16 mg/kg ± 4.87 mg/kg found in farm 3 and lowest concentration of Cr was 6.60 mg/kg ± 1.77 mg/kg found in farm 1. Present study founded that the highest concentration was found 3.433 mg/kg in Gher-6 and the lowest concentration were found 1.957 mg/kg in Gher-1. WHO and FAO recommended a permissible limit for Cr concentration in sediment for shrimp farming, which is 5 mg/kg. Cr concentration of the selected six shrimp Gher was lower than the maximum allowable limit. Swarna Das et al. (2017) reported that, the range of concentration of lead (Pb) was to 6.34 mg/kg to 7.92 mg/kg found in farm 2 and 3 in the bottom sediment. Present study found that the highest concentration was found 1.113 mg/kg in Gher-2 and the lowest concentration were found 0.921 in Gher-1. WHO and FAO recommended a permissible limit for Pb concentration in water for shrimp farming, which is 0.3 mg/kg. Pb concentration of the selected six shrimp Gher was higher than the maximum allowable concentration limit. Aktaruzzaman and Hossain (2013) reported that, the level of cadmium (Cd) varied in sediment samples from 0.116 - 0.160 mg/kg. Present study founded that highest concentration was found 4.10 mg/kg in Gher-6 and the lowest concentration was found 3.805 mg/kg in Gher-2. WHO and FAO recommended a permissible limit for Cd concentration in sediment for shrimp farming, which is 0.2 mg/kg. Cd concentration of the selected six shrimp Gher was higher than the maximum allowable concentration limit. Guhathakurta and Kaviraj (2000) documented that, concentration of Zn in the surface layer of the sediment (upto 10.0 cm depth) ranged from 40.8 to 3448.3 µg.g-1. Present study founded that the highest concentration was found 265.716 mg/kg in Gher-2 and the lowest concentration were found 205.76 mg/kg in Gher-1. Zn concentration of the selected six shrimp Gher was lower than the maximum allowable concentration limit. WHO and FAO recommended a permissible limit for Zn concentration in sediment for shrimp farming, which is 40 mg/kg.

Table 3 indicates the outcomes of the physioco-chemical conditions of various shrimp Gher water samples. The values of temperature, pH and DO of shrimp Gher water were determined to be adequate for cultivation of shrimp, whereas the high values of TDS, turbidity and EC were recorded. On the other hand salinity levels were suitable for cultivating shrimp. The temperature was roughly within the range of the ideal temperature (32°C) for shrimp culture (Chiu et al. 1988). The present study founded that the mean temperature of the waterbody is approximately (23°C). Ramanathan et al. (2005) reported that ideal pH range (6.8 to 8.7) should maintained for maximum growth and production of shrimp. The recorded values of pH of all studied shrimp Gher water were slightly deviating from the ideal range (7.5-8.5), that range recommended by Chiu et al. (1988) for ideal shrimp culture. The present study founded that the mean pH of the Gher is 8.52. The Dissolve oxygen in Gher water range from 4.85 mg/l to 8.72 mg/l.

The average water Dissolve oxygen is 6.88 mg/l. The minimum water Dissolve oxygen is found in *Gher*-1 and maximum Dissolve oxygen is found in *Gher*-2. An optimum range of DO for shrimp farming is >5 mg/l which was recommended by WHO and FAO. Except *Gher*-1, All the selected farm of DO are exceeded the permissible allowable limit. The salinity of all the shrimp *Gher* water was measured to be between 8.78 and 10.48 ppt, despite the fact that the ideal salinity is 15 to 25 ppt for the culture of shrimp (Boyd, 1995), which is essential in pond dynamics. The six mixed shrimp *Gher* water samples had their turbidity analyzed, and the results ranged from 50.8 to 348 NTU, which was outside of the ideal range (7 to 30) suggested by Lin et al. (1993). The total dissolve solids in *Gher* water range from 2280 mg/l to 5250 mg/l. The average water total dissolve solids are 4331.63 mg/l. The minimum water total dissolve solids are found in *Gher*-1 and maximum water total dissolve solids is found in *Gher*-3. The optimum level of TDS value is 1000 mg/l which is recommended by WHO and FAO. The Electrical conductivity in *Gher* water range from 4380 to µs/cm 9570 µs/cm. The average water Electrical conductivity is 8053.33 µs/cm. The minimum water Electric conductivity is found in *Gher*-1 and maximum water Electric conductivity is found in *Gher*-3. The optimum EC value is 1000 µs/cm which is recommended by WHO and FAO. The Bicarbonate in *Gher* water range from 219.6 mg/l to 445.3 mg/l. The average water Bicarbonate is 345.67 mg/l. The minimum water Bicarbonate is found in *Gher*-1 and maximum water Bicarbonate is found in *Gher*-5. The optimum level of HCO_3^- value is 200 mg/l which is recommended by WHO and FAO. The selected all farms of HCO_3^- are above the standard. The Sulphate in *Gher* water range from 0.38 mg/l to 5.72 mg/l. The minimum water Sulphate is found in *Gher*-2 and maximum water Sulphate is found in *Gher*-5. The optimum level of SO_4^- value is 8 mg/l which is recommended by WHO and FAO. The selected all farms of SO_4^- value are lower than permissible allowable limit. The Nitrate in *Gher* water range from 0.356 mg/l to 1.94 mg/l. The minimum water Nitrate is found in *Gher*-1 and maximum water Nitrate is found in *Gher*-3. The permissible standard of NO_3^- for shrimp farming is 100 mg/l which recommended by WHO and FAO. The NO_3^- of all six farms are very lower than the standard values. The Phosphate in *Gher* water range from 0.132 mg/l to 0.826 mg/l. The minimum water Phosphate is found in *Gher*-1 and maximum water Phosphate is found in *Gher*-5. The optimum level of PO_4^- value is 0.2 mg/l which is recommended by WHO and FAO. The selected all farms of PO_4^- value are higher than permissible allowable limit.

Conclusion

The value of physico-chemical parameters (EC, TDS, Turbidity, HCO_3^-/CO_3^-, NO_3^-) are higher than internationally recommended WHO and FAO allowable limit. The concentration values of Cadmium (Cd), Chromium (Cr), Lead (Pb) in water and Cadmium (Cd), Zinc (Zn), Lead (Pb) in sediment samples are higher than internationally recommended permissible limit WHO and FAO. A sustainable environmental management is necessary to control the heavy metal pollution in the studied water bodies as well as sediment too.

Table 3.Physico-chemical conditions of the waterbodies of *Gher*

Sampling Spot	Temp (°C)	pH	DO (mg/l)	BOD_5 (mg/l)	Salinity (ppt)	Turbidity (NTU)	EC (µs/cm)	TDS (mg/l)	HCO_3^-/CO_3^- (mg/l)	SO_4^- (mg/l)	NO_3^- (mg/l)	PO_4^- (mg/l)
Gher-1	21.3	8.19	4.85	1.36	9.25	63.6	4380	2280	219.6	1.48	0.37	0.13
Gher-2	21.2	8.62	8.72	1.45	9.2	218	9570	5180	274.5	1.38	1.45	0.6
Gher-3	21.9	8.75	6.8	1.56	8.78	75.6	9670	5250	402.6	5.72	1.94	0.45
Gher-4	23.2	8.33	5.8	1.42	9.93	348	9490	5150	347.7	1.08	1.16	0.14
Gher-5	23.6	8.51	7.55	1.46	10.48	81.9	6060	3180	445.3	0.39	0.94	0.83
Gher-6	23.5	8.69	7.58	1.45	9.89	50.8	9150	4950	384.3	5.14	0.8	0.38
Mean	22.45	8.52	6.88	1.45	9.59	139.65	8053.33	4331.67	345.67	2.53	1.11	0.42
Maximum	23.6	8.75	8.72	1.56	10.48	348	9670	5250	445.3	5.72	1.94	0.83
Minimum	21.2	8.19	4.85	1.36	8.78	50.8	4380	2280	219.6	0.39	0.37	0.13
Std. Deviation	1.11	0.22	1.39	0.07	0.62	118.88	2264.83	1276.77	84.41	2.28	0.55	0.27
WHO/FAO standard	28-31	7-8.5	>5	<50	10-30	5	1000	1000	100-200	3-8	10	<0.2

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Conflict of interest
No conflict of interest exists.

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