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# The Amount of the Selected Metals in Soils and River Water of Gopalgonj, Bangladesh

**Md. Matiar Rahman[1*] and Tamanna Pinky[1]**

*[1]Department of Chemistry, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj, Bangladesh.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. Author MMR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MMR and TP managed the analyses of the study. Authors MMR and TP managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The contaminations and exposures of some metals recognized as a risk to human health owing to consumption of components through water and atmosphere. Nine composite samples consist of five completely different waters and four soils were collected from the various places of Gopalgonj, Bangladesh. These were digestible and examined, during this study. Quantifications of various metals from the composite specimens were created by Atomic Absorption spectrophotometer strategies (AAS) against commonplace activity plot. The frequency of metals were determined within the order of soil > waters. Concentration of the following metals Cd, Cr, Cu, Fe, Mn, Zn, Ca and Mg for soil samples is more than that of water samples. With increasing concentrations of Co, Ni, Na and K were determined in waters compared to soils. Very low concentrations of metals were found from water samples. The Fe, Cr, Ni, Na and Mn concentrations exceeded the approved permissible levels in soils specimens and rests were among permissible limit.

*Keywords: Heavy metals; irrigated soils; stream waters.*

**Corresponding author: Email: matiar@bsmrstu.edu.bd;*

## 1. INTRODUCTION

Many components are essential nutrients for the expansion and survival of humans and any other organisms. Though necessary, the metal nutrients need to lie slender vary associate degreed severe imbalance of components proportions could cause exposure to elevated concentrations that will induce to death of fish and high illness to human [1-2]. As a result, investigation of major, minor, cyanogenic and trace components in biological, agricultural produces and environmental matrices has gained a definite interest owing to the vital role in human health [3-4]. Thus, these serious problems draw special attention of world great scientists to research the metal nutrients in fruits, vegetables, soils, waters and surrounds environments and to correlate the metal contaminations routes in dietary phenomenon [5-7]. Studies have shown the transfers of nutrients and cyanogenic metals such as Pb, Cd and As from ground to the ocean by a little Mediterranean stream [8]. River systems are a major routes for transportation of metals and trace components could become vital pollutants of the many little stream banks and lakes [9-11]. More studies prompt that the behaviour of metal in waters of the substrate sediments, the suspended solid composition and also the water chemistry [12]. In the course of transport, the trace metals bear varied changes in their phylogeny due to dissolution, precipitation, activity and complexation phenomena that have an effect on their behaviour and bioavailability [13]. Hobbelen (2009) incontestible that the hydrocarbons, trace metals and chlorinated compounds in soil, water and also the atmosphere are an increasing at associate degree ominous rate inflicting deposition and deposit in water reservoirs.

The observance of metals convenience in the surface is primarily derived from soil, precipitation and stream systems. Soils are variably contaminated with metals as a result of human activities as well as transportation, construction, producing, fuel combustion, and emissions [14-15]. Consequently, soils may be contaminated, moderately to severely, with serious cyanogenic metals like Pb, Cd, and Hg and possibly to cause some hazard for garden foods and human health [16]. Their long deposition could scale back soil buffering capability and cause soil and groundwater contamination [17]. The trace metal contaminations grow each year, presenting a heavy drawback for human health [18].

Metals are not seem to be perishable and that they could accumulate up in organic phenomenon from soil metals throughout the expansion and process. Heavy metals are one among the common forms of contaminants that was found in plants, fruits and vegetable salads [19]. Contamination of fruits and vegetables with metals could also be because of irrigation with contaminated water, metal-based pesticides and fertilizers, high traffic areas, industrial emissions, transportation, the gather method, and storage [20]. In addition, fruits and vegetables could also be contaminated once farmers wash the merchandise with contaminated waste before transportation them to the grocery store – this case could happen particularly in South Asian developing countries herein Bangladesh wherever water resources area unit restricted for framing land and farmers. Sharma (2009) rumoured that transportation and selling systems of vegetables play a vital role in elevating the contamination levels of serious metals that will cause a threat to the standard of the vegetables. Mor and Ceylan (2008) have determined higher levels of Pd and Cd within the vegetable adult in traffic areas than those found in rural areas. Vegetable adult at contaminated sites may take up and accumulate metals at concentrations that area unit cyanogenic. Though some metals area unit micronutrients, they're cyanogenic in high concentrations [21]. Increased serious metal concentrations could result in a high quantity of human intake, inflicting serious unwellness [22]. The Gopalgonj Sador Upazilla, Gopalgonj district, Bangla Desh has been hand-picked within the gift study of soil and water. The Gopalgonj Sador Upazilla could be a non-industrial and non-traffic zone however through farming land activities soils and water. Farmers utilize heavy chemical fertilizers, pest controls in farming lands to grow numerous plants, fruits and vegetables in the soils and river waters for their cultivation.

Finally, agriculture produces square measure taken and transported to the native supermarkets as a dietary food. As plants establish the premise of the fruits and vegetables, some considerations are raised concerning the chance of virulent concentrations of sure parts being routed from plants to dietary food [23]. Moreover, vegetables, consumed raw or parched, might cause additional hazards as a result of the change of state method is ineffective which will cut back metal concentrations. Significant metals may additionally deposit on the surface of the fruits and vegetables, or even haunted by the crop roots and incorporated into the plant structure. Metal deposited on the surface of the crop will typically be washed off by shoppers before their consumption. visible of those facts, we have a tendency to analyze the concentrations of various significant metals in waters and soils assembling from the Gopalgonj locality, Gopalgonj district of Bangladesh.

## 2. MATERIALS AND METHODS

### 2.1 Chemical and Instrumentation Used

The Individual standards of AAS grade stock solution 1000 mg/L such as Pb, Cd, Cr, Cu, Co, Ni, Fe, Mn, Zn, Ca, Mg, K and Na were purchased from Spectro Pure, USA. The operating customary solution was ready by diluting the stock solution of one component with ultra-pure water. Highly pure $HNO_3$ was obtained from E. Merck, Germany. All additionally needed chemicals were ultra pure receive bd from E. Merck, Germany. Flame and plumbago chamber atomic absorption spectroscopic analysis [(AAS), Varian Analytical Instruments, Models AA DUO 240 FS and AA 280 Z were utilized in this study.

### 2.2 Description of Study Location Choice and Observation Station

The study site was chosen a part of the well-known Gopalgonj Upazila underneath Gopalgonj district in Bangladesh. Gopalgonj space of Gopalgonj district is not treated as associate industrial zone however plays a dominant role in economic process of the district. Though the Gopalgonj is not associate industrial zone, it drives the economic power of the total district through farming land and agriculture commodities, wherever significant utilization of chemical fertilizers and also the Madhumati stream waters area unit evident. In a temporary description of the sampling sites, Gopalgonj and Gopalgonj district is within the northern region of Bangladesh. From the traditional time, Gopalganj may be a district within the Dhaka division of Bangladesh. The district has concerning 1,172,415 civilians and its extent is 1,490 km². It stands on the bank of the Madhumati stream and settled at 23°00’47.67" to 89°49’21.41" N. Faridpur district is located on the North, Pirojpur and Bagerhat district are on the South, Madaripur and Barisal district are on the East and Narail district is on the West of the Gopalganj district.

### 2.3 Sampling Amount, Sampling of the Samples, Sample Preparation and Analysis

Water and soils specimens were collected on March 19, 2019, at the beginning of the winter season.

#### 2.3.1 Water samples

The water samples were collected from four completely different stations. the space between the sampling purpose was concerning. Water samples were grabbed from every observation station more or less 2m depth from the surface of the water. the quality water sampler (Hydro Bios, Germany) was used with six pre-cleaned five hundred cubic centimetre volume polyethene bottles to gather the water from every sampling site. Then waters from six bottles (6 x 500 mL=3L) were mixed along to get a composite sample. Followed the composites were filtered through 0.45 µm membrane filters. Ultra-pure acid was bring down the pH to <2.0 and hold on the samples at 4°C in sampling kits and shipped to the laboratory for significant component analysis.

#### 2.3.2 Soil samples

Fifteen top-soil samples were collected from five to twenty cm depth from 5 completely different vegetable fields/stations employing a Teflon coating knife during this study. the space between every observation station was concerning a 100m. Three replicates top-soil samples were grabbed from every observation station. more or less 3.0 kg (3 x 1000.0 g) of the samples were collected and straightaway transferred into 3 new individual nothing lock luggage characteristic with applicable sample range, sampling location employing a permanent marker. The collected soil samples were air dried for many days in Pyrex Petri dishes so kitchen appliance dried at a 105℃ to realize a relentless weight. Followed the samples were grounded in mortar and screened through a 2.0 mm sieve to get a homogeneous powder. The homogeneous powders of 3 replicate from every observation station were mixed along uniformly and ready a composite proportional sample. So total 5 representative samples were ready and hold on in air-sealed clean plastic vials within desiccators for any analysis. The names of soil sampling fields that corresponded to the vegetable fields are given in Table 1.

#### 2.3.3 Digestion of soil and water samples for metal content analysis

To determine the concentration of metals within the soil, aliquot quantity (about 0.1 g) of the bottom specimens were taken in an exceedingly XP vessel wherever 6 ml of focused $HNO_3$ was poured. Samples were then digestible in an exceeding microwave accelerator reaction system following USA independent agency procedure 3051A. Briefly, a sample of up to 0.5 g was digestible in 10 ml of focused acid for 10 minutes microwave heating with an acceptable laboratory microwave unit. The sample and acid were placed in an exceedingly halocarbon microwave vessel. The vessel was capped and heated within the microwave unit. when cooling, the vessel contents were filtered, centrifuged, or allowed to settle and so diluted to a volume of 10 ml with de-ionized water in an exceedingly 10 ml volumetrical flask. Triplicates measurements were performed. Finally, the samples were analysed by using AAS for metal estimation.

#### 2.3.4 Metal determination

Triplicates analysis was performed to see serious and trace metals in each water and sediment specimens collected from every observation station and amount. Flame and plumbago chamber AAS were utilized. The metal commonplaces ready were checked with standard reference material obtained from the National Institute of Standards and Technology (NIST), the USA before every metal analysis and also the deviation was found to be insignificant. Average values of 3 replicate were taken for every determination. Operational conditions were adjusted to yield the best determination. Quantification of metals was primarily based upon standardisation curves of ordinary solutions of metals.

#### 2.3.5 Standardisation curve and quality assurance

The known concentrations of every reference commonplace answer were not to prepare standardisation levels. Constant of variation (R2 value) derived from statistical method analysis exceeded 0.9995 for all parts. Individual standardisation curve was used to verify the concentrations of every element/metal. The detection limit of every target elements/metals were ascertained and tabulated in Table 2. Quality assurance includes procedural blanks that were used throughout sample preparations to gauge contamination from the chemical agent, container, etc. No contamination was detected within the blanks. Procedures for sample preparations and experiments were valid by effecting all operations in triplicate.

**Table 1. Info of water and soil specimens collected from sampling sites of Gopalgonj for this study**

| Sl. No. | Sample iID | Samplingisites |
|---|---|---|
| 01 | SS-001 | Ghonapara |
| 02 | SS-002 | Tungipara |
| 03 | SS-003 | Gobra |
| 04 | SS-004 | Sonakour |
| 05 | SS-005 | Kashiyani |

**Table 2. Limit of detection of target metals in water and soil samples**

| Target metals | Water (g/L) | Soil (mg/L) |
|---|---|---|
| Pb | 20.0 | 2.333 |
| Cd | 3.0 | 0.233 |
| Cr | 4.0 | 1.933 |
| Co | 3.80 | 1.266 |
| Cu | 2.40 | 0.800 |
| Ni | 3.70 | 1.233 |
| Fe | 3.90 | 1.300 |
| Mn | 1.90 | 0.633 |
| Zn | 0.67 | 0.223 |
| Ca | 14.6 | 4.866 |
| Mg | 0.24 | 0.080 |
| Na | 0.23 | 0.076 |
| K | 1.76 | 0.586 |

## 3. RESULTS AND DISCUSSION

Madhumati River waters are used to cultivate fruits/vegetables within the farming lands at Gopalgonj area of Bangladesh. during this study, soils and water samples collected from Gopalgonj location are accustomed to confirm the serious metal concentrations within the specimens.

### 3.1 Water Samples Analysis

The watercourse water accustomed grow the vegetables were composited and analyzed by AAS for determination of metal as well as Pb, Cd, Cr, Cu, Co, Ni, Fe, Mn, Zn, Ca, Mg, Na and K. Table 3 shows the comparison of the concentrations of target metals between composite water samples and drinking/irrigation water. The metals Pb, Cd, chromium and Co weren't found to be detected in four water composite specimens. The discovered Pb concentration was more or less a pair of to three times under drinking or irrigation water permissible limit. The Cu, Ni, Fe, Mn and Zn concentrations were discovered as 5.2 – 11.0, 3.0 – 22.2, 507 – 558, 5.1 – 24.8 and 10.0-18.0 ug/L in four composite samples and these values are more or less 10 to 100 times under admission levels of corresponding parts.

The concentrations of Ca, Mg, atomic number 11 and K ranged from 20.0 – 20.5, 6.5 – 8.0, 40.2 – 50.6 and 8.3 – 10.7 mg/L, severally, were obtained within the water samples and these parts are thought-about to be most essential and no comparison was created in absence of ordinary limit availableness.

The water samples collected from completely different spots of the watercourse and analyzed indicate that the 13 target metals concentrations were below of the standards allowable limits. The common concentrations of serious metals (macro-nutrients) level were within the order of Fe > Na > Ca > Mn > Zn > Mg > K > Cu.

### 3.2 Soil Samples Analysis

Five soils were collected from the spots pf the lands wherever fruits and vegetables were cultivated. These samples were subjected and analyzed the concentration of metals as well as Pb, Cd, Cr, Cu, Co, Ni, Fe, Mn, Zn, Ca, Mg, Na and K. Table 4 summarizes the ascertained concentration of target metals in soil specimens. No matter soil samples assortment points, all target metals were detected in numerous concentration ranges. The Pb, Cd, Cr, Cu, Co, Ni, Mn, metal and Mg were not up to the quality admittable levels. The obtained values ranged from 28 to 32 mg/kg for Pb, 0.5 to 0.6 mg/kg for Cd, 32 to 36 mg/kg for harmful Cr, 14.0 to 18.5 mg/kg for Cu, 17.0 to 18.5 mg/kg for Co, 37 to 40 mg/kg for Ni, 350 to 408 mg/kg for Mn, 190 to 210 mg/kg for Zn and 0.85 to 1.1 mg/kg for Mg. within the case of common metal Fe, the concentration was found as 25 to 33 mg/kg that is 100 times over the quality levels in the soil.

### 3.3 Analysis of Water and Soil Samples

Target metal concentrations in sampled water and soils were evaluated supported the comparison of their average values and are displayed in Table 5. In general it's been ascertained that most numbers of target metals were ascertained in soils. the smallest amount variety of metals were obtained in water samples. In majority instance, the upper concentrations of Pb, Cd, Cr, Cu, Fe, Mn, Zn, Ca and Mg were found in soil than water. within the case of vegetables, increasing concentrations of Co, Ni, Na and K were determined compared to soils and water. no matter metals thought water samples provided the least values.

**Table 3. Concentrations of metals in water specimens collected from the sites of Gopalgonj, Bangladesh**

| Target/ Metals | Irrigation | Drinking | WS-01 | WS-02 | WS-03 | WS-04 | Average conc. |
|---|---|---|---|---|---|---|---|
| Pb (mg/L) | 0.10 | 0.05 | 39 | <22 | <22 | <22 | 39.0 |
| Cd (mg/L) | 0.05 | 0.005 | <3.2 | <3.2 | <3.2 | <3.2 | <3.2 |
| Cr (mg/L) | 1.00 | 0.001 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Cu (mg/L) | 3.00 | 1.00 | 11.0 | 10.0 | 5.2 | 8.5 | 8.5 |
| Co (mg/L) | 0.05 | 0.05 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| Ni (mg/L) | 1.00 | 0.10 | 18 | 22.2 | 17.0 | 20.0 | 19.3 |
| Fe (mg/L) | 2.00 | 1.00 | 507 | 558 | 512 | 546 | 530 |
| Mn (mg/L) | 5.00 | 0.10 | 15 | 20 | 12 | 11 | 14.5 |
| Zn (mg/L) | 10.0 | 5.00 | 18 | 10 | 14 | 12 | 13.5 |
| Ca (mg/L) | NC | NC | 21 | 20 | 20.6 | 20.7 | 20.6 |
| Ma (mg/L) | NC | NC | 6.5 | 8 | 7.5 | 6.5 | 7.2 |
| Na (mg/L) | NC | NC | 40.2 | 45.5 | 50.3 | 50.6 | 47.7 |
| K (mg/L) | NC | NC | 8.3 | 10.5 | 10.7 | 9.5 | 9.8 |

*WS= Water sample*

**Table 4. Concentrations of different metals in soil collected from the location of Gopalgonj, Bangladesh**

| Target metals in (mg/Kg) | Soil | SB-01 | SB-02 | SB-03 | SB-04 | SB-05 | Average |
|---|---|---|---|---|---|---|---|
| Pb | 250-500 | 32 | 30 | 28 | 28.5 | 29 | 29.5 |
| Cd | 3-6 | 0.6 | 0.6 | 0.55 | 0.5 | 0.55 | 0.54 |
| Cr | 200 | 36 | 32 | 34 | 36 | 36 | 34.8 |
| Cu | 140-200 | 14.0 | 17.0 | 18.0 | 17.0 | 18.5 | 16.8 |
| Co | 20 | 17 | 18.5 | 18.2 | 17.5 | 18 | 17.8 |
| Ni | 60 | 40 | 38 | 37 | 40 | 39 | 38.8 |
| Fe | 75-150 | 25 | 30 | 32 | 33 | 30 | 30 |
| Mn | 630 | 408 | 401 | 390 | 350 | 360 | 382 |
| Zn | 300-600 | 210 | 190 | 195 | 202 | 205 | 200.4 |
| Ca | NC | 5.1 | 4.9 | 5.0 | 5.2 | 4.8 | 5.0 |
| Mg | NC | 1.0 | 0.90 | 0.85 | 1.1 | 1.0 | 0.97 |
| Na | NC | 4.1 | 4.0 | 3.4 | 3.5 | 3.6 | 3.6 |
| K | NC | 1.2 | 1.1 | 1.2 | 1.0 | 1.2 | 1.1 |

**Table 5. Comparison of average metals concentration of soils and Madhumoti river water of Gopalgonj, Bangladesh**

| Target metals | Soil (mg/Kg) | Water (mg/Kg) |
|---|---|---|
| Pb | 39.0 | 29.5 |
| Cd | <3.2 | 0.54 |
| Cr | <4.0 | 34.8 |
| Cu | 8.5 | 16.8 |
| Co | <3.0 | 17.8 |
| Ni | 19.3 | 38.8 |
| Fe | 530 | 30 |
| Mn | 14.5 | 382 |
| Zn | 13.5 | 200.4 |
| Ca | 20.6 | 5.0 |
| Mg | 7.2 | 0.97 |
| Na | 47.7 | 3.6 |
| K | 9.8 | 1.1 |

## 4. CONCLUSION

A series of metals like Pd, Cd, Cr, Cu, Co, Ni, Fe, Mn, Zn, Ca, Mg, Na and K were targeted to look at the concentration in Madhumoti stream water and totally different soil specimens from the Gopalgonj area of Bangladesh. within the case of water, the typical concentrations of macro-nutrients metals were determined within the order of Fe > Na > Ca > Mn > Zn > Mg > K and Ni > Cu. For soils, the order was Fe > Mg > Ca > K > Na > Mn > Zn supported average concentration values and for trace and virulent parts were Ni > Cu > Cr > Pb > Co > Cd. For water samples provided the concentration within the K > Ca > Na > Mg > Fe > Mn > Zn and their values were higher concentration of course due to healthy habits demand that is more associate degree order of Ni > Co > Cu > Cr was found in the water sample. Excepting minor pollution concern of iron, chromium, nickel and manganize, all other metals in water samples were determined among the permissible limit of international and national health regulatory authorities.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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