CHARACTERIZATION OF DOMESTIC WASTEWATER AT BHUBANESWAR, ODISHA, INDIA

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KEYWORDS
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Bhubaneswar
Physicochemical parameters

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INTRODUCTION

Domestic wastewater (sewage) is generated from residential, institutional, commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens, sinks etc. that is disposed via sewers. Sewage may also include storm water runoff. As rain water travels over roofs and the ground, it may pick up various contaminants. Sewage is the major source of water pollution in India, especially in and around large urban centres. There is a wide gap between the demand and supply of water (Sreerangam, 2005). Sewage is mainly composed of 99.9% of water together with relatively small concentrations of suspended and dissolved organic and inorganic solids. Dissolved solids formed the main part of total solids concentrations as compared to the suspended solids (Ayub et al., 2011). Organic substances present in sewage are carbohydrates, lignin, fats, protein and their decomposed products, soaps as well as various natural and synthetic organic chemicals from the process industries. Sewage also contains the inorganic substances from domestic and industrial sources, including a number of potentially toxic elements such as cadmium, chromium, copper, lead, zinc and iron (Dash, 2010; Dipak and Arti, 2011). Besides this domestic waste water also contains a good number of pathogenic microbes. Periodical monitoring of water quality is necessary in the area of industrial establishments, so that appropriate steps may be taken for water resource management practices (Kanase et al., 2005; Dipak and Arti, 2006). In the present study, an attempt has been made to characterise the sewage collected from three important locations of Bhubaneswar city.

Study area

Bhubaneswar, the capital of Odisha is known as the “Temple City of India”. It is situated between Latitude- 20°12' N to 20°25' N and Longitude 85°44' E to 85°55' E. The city has a population of 6, 57,477 as per 2001 census. It is situated on the South Eastern Railway line joining Howrah and Chennai at a distance of 435km South of Kolkata. Bhubaneswar is well connected with the main cities of Kolkata, Chennai, Hyderabad and Visakhapatnam by highways, railways and airways. NK-5, NH-203 passes the city. Table I shows the land use pattern of Bhubaneswar.

Wastewater generation and drainage system

It is estimated that, 182 MLD of water is daily supplied to the city, out of which 145.6 MLD sewage is generated which is 80% of the total water supplied. There is no integrated sewage treatment facility in the city. The absence of sewerage system, people are using septic tanks and soak pits. The city has an undulating ridge and valley topology and is covered by a number of natural drainage channels. The city is in the western side of river Kuakhai and to the northern part of river Daya. Apart from this a number of open drains running west to east criss-cross the city. The drainage is controlled by Kuakhai and Daya River. Most of the sewage from the city reaches river Kuakhai and river Daya through open drains. The entire city has not been covered with surface water drain. There are about 10
open drains in the city of Bhubaneswar discharging wastewater. Table 2 shows the name of major drains with their starting point, outfall point, major areas covered, length (sq. Km.) and average discharge of waste water (MLD) of Bhubaneswar.

MATERIALS AND METHODS

Municipal waste water samples were collected from three different locations (Table 3) was brought to the laboratory for analysis of various physico-chemical parameters (APHA, 1995). Samples were collected from about 30-40cm below the surface, to avoid the collection of surface impurities, oil etc. The time period between sampling and analysis was kept to a minimum.

RESULTS AND DISCUSSION

The physicochemical analysis results with their minimum and maximum range, mean ± standard deviation values for S1, S2 and S3 are shown in Table 4, Table 5 and Table 6 respectively.

<table>
<thead>
<tr>
<th>Drain Drainname</th>
<th>Starting point</th>
<th>Outfall point</th>
<th>Major areas</th>
<th>Length in km²</th>
<th>Average discharge (MLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patia</td>
<td>Forest Lake, Chandrasekharpur</td>
<td>Daya West, Canal Crossing to</td>
<td>C. S. Pur, Damana, Garkhana, Patia, Mancheswar</td>
<td>4.32</td>
<td>17.00</td>
</tr>
<tr>
<td>2. Sainik School</td>
<td>Sainik School Road Culvert</td>
<td>Railway Bridges (confluence</td>
<td>Samanta Vihar, Vani Vihar, Garkana</td>
<td>1.13</td>
<td>1.55</td>
</tr>
<tr>
<td>3. OAP area</td>
<td>Near Sainik School</td>
<td>Drain No. 3) to Gangua Nallah</td>
<td></td>
<td>2.42</td>
<td>3.55</td>
</tr>
<tr>
<td>4. Vani Vihar</td>
<td>Culvert near Reserve forest,</td>
<td>Daya West Canal Crossing to</td>
<td>Nayapalli, Madusadan Nagar, Vanivihar, Pandra, Garkana, Bhoinagar</td>
<td>5.63</td>
<td>16.40</td>
</tr>
<tr>
<td>5. Laxmisagar Area</td>
<td>in Jan path Road</td>
<td>Gangua Nallah</td>
<td>Kesar Nagar, Charbatia, East Bargarh, Laxmisagar, Ashok Nagar</td>
<td>3.13</td>
<td>4.45</td>
</tr>
<tr>
<td>6. Baragada Area</td>
<td>Railway Bridges</td>
<td>Gangua Nallah</td>
<td></td>
<td>2.16</td>
<td>3.45</td>
</tr>
<tr>
<td>7. Kedargouri</td>
<td>Culvert in Air Port Road</td>
<td>Gangua Nallah</td>
<td>Gautam Nagar, West Bargada, Nuagaon</td>
<td>4.34</td>
<td>5.45</td>
</tr>
<tr>
<td>8. Airport area</td>
<td>Joklandi Road</td>
<td>Confluence with Drain no. 8 to</td>
<td>Baramunda, Jokalendi, Jagmara</td>
<td>4.33</td>
<td>14.30</td>
</tr>
<tr>
<td>9. Ghatakia</td>
<td>Culvert on NH-5</td>
<td>Pokhariput Railway Bridge to</td>
<td>Aiginia, Dumduma, Jagmara, Madhusudan Nagar, Bhoinagar, Satyanagar</td>
<td>4.24</td>
<td>28.8</td>
</tr>
<tr>
<td>10. Nicco park</td>
<td>Lake Near CRP Colony</td>
<td>Gangua Nallah</td>
<td></td>
<td>5.48</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Table 2: Major drains (Nallahs) in Bhubaneswar city

Colour and Odour
Both colour and odour are the two physical parameters of a water/wastewater sample. In the present investigation, colour is light black and odour is unpleasant in all the three monitoring stations. This gives an idea about the organic contamination of the domestic wastewater.

pH
The average pH in S1 is 6.45 which vary between 6.3-6.6, at S2 the average value is 7.28 which varies between 7.2-7.4 and in S3 the average value is 7.17 and it varies between 7.15-7.2. It shows that, the average pH in the three stations varies between 6.45-7.28. The pH of S1 is slightly acidic and in S2 and S3 it is slightly alkaline. The average pH in all the three stations are within the standard (5.5-9.0) for disposal into inland surface water. Fig. 1a shows the difference in average pH in all the three monitoring stations.

Total Suspended Solids (TSS)
TSS varies between 241-250 with an average value of 245.75 in S1, 338-345 with an average value of 342.25 at S2 and 282-287 with an average value of 285 at S3. The average TSS in all the three stations varies between 245.75-342.25. In all the three stations TSS values are above the prescribed standard (1000 mg/L). In some places, the municipal drain is open which receives the surface runoff water that might contribute the increase in TSS of the domestic wastewater. Increase in TSS reduces the transparency of the wastewater. Fig. 1b shows the comparison between TSS in all the three monitoring stations.

Total Dissolved Solids (TDS)
TDS varies between 625-631 and average is 625.3 in S1, 738-741 with an average value of 739.5 at S2 and 789-794 and average is 791.3 in S3. The average values vary between 625.3-791.3
Table 3: Locations and name of sampling stations

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Drain name</th>
<th>Sampling point</th>
<th>Sampling station code</th>
<th>Length of drain in km²</th>
<th>Drain area in km²</th>
<th>Average discharge (MLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nicco park</td>
<td>Jharpata</td>
<td>S 1</td>
<td>5.48</td>
<td>10.28</td>
<td>12.3</td>
</tr>
<tr>
<td>2</td>
<td>Laxmisagar area</td>
<td>Kesari Nagar</td>
<td>S 2</td>
<td>3.31</td>
<td>3.66</td>
<td>4.45</td>
</tr>
<tr>
<td>3</td>
<td>Kedargouri</td>
<td>Goutam Nagar</td>
<td>S 3</td>
<td>4.34</td>
<td>9.46</td>
<td>5.45</td>
</tr>
</tbody>
</table>
values are within the limit.

Total Hardness

Calcium and magnesium hardness in a water sample determines the total hardness of the sample. In the present investigation in S1 the hardness varies between 326-333, in S2 it varies between 275-280 and in S3 it is 283.5-286.7. Further, the average value in S1, S2 and S3 were found to be 329.7, 277.5 and 285 respectively (Fig. 1h).

Biochemical Oxygen Demand (BOD)

Presence of organic matter in a wastewater sample determines the BOD value. The BOD standard for disposal of sewage into inland surface water is 30mg/L. In the present investigation, the average BOD at S1 is 139 which varies between 136-142, at S2 and average BOD is 114.5 which varies between 105-120 and at S3 the average BOD is 108 which varies between 101-114. This shows that the average BOD value (Fig. 1i) exceeds the permissible limit in all the three stations. Increase in BOD of a sample decreases the DO concentration. Therefore, domestic wastewater before discharge outside must be treated to bring the value with the standard.

### Table 4: Physico-chemical characteristic of domestic wastewater at S1

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Parameters</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Standard for disposal into inland surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Colour</td>
<td>Light Black</td>
<td>Light Black</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Odour</td>
<td>Unpleasant</td>
<td>Unpleasant</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>pH</td>
<td>6.3-6.6</td>
<td>6.45 ± 0.129</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>4.</td>
<td>TS mg/L</td>
<td>241-250</td>
<td>245.75 ± 3.774</td>
<td>100</td>
</tr>
<tr>
<td>5.</td>
<td>TDS mg/L</td>
<td>625-631</td>
<td>628.3 ± 2.753</td>
<td>2100</td>
</tr>
<tr>
<td>6.</td>
<td>Turbidity (NTU)</td>
<td>85-94</td>
<td>89.5 ± 3.872</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Chloride (as Cl)</td>
<td>685-693.5</td>
<td>689.1 ± 3.837</td>
<td>1000</td>
</tr>
<tr>
<td>8.</td>
<td>Oil and Grease mg/L</td>
<td>1.7-3</td>
<td>2.173 ± 0.567</td>
<td>10</td>
</tr>
<tr>
<td>9.</td>
<td>Total Kjeldahl Nitrogen(N) mg/L</td>
<td>7.9-9.16</td>
<td>8.613 ± 0.53</td>
<td>100</td>
</tr>
<tr>
<td>10.</td>
<td>Total Hardness mg/L</td>
<td>326-333</td>
<td>329.7 ± 3.238</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Biochemical Oxygen Demand (3 days at 27ºC) mg/L</td>
<td>136-142</td>
<td>139 ± 2.581</td>
<td>30</td>
</tr>
<tr>
<td>12.</td>
<td>Chemical Oxygen Demand mg/L</td>
<td>307-313</td>
<td>310.3 ± 2.753</td>
<td>250</td>
</tr>
<tr>
<td>13.</td>
<td>Alkalinity mg/L</td>
<td>71-76</td>
<td>73.5 ± 2.38</td>
<td>-</td>
</tr>
<tr>
<td>14.</td>
<td>Sodium (as Na) mg/L</td>
<td>77-82</td>
<td>79 ± 2.16</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>Potassium( as K) mg/L</td>
<td>19-26</td>
<td>22.8 ± 2.99</td>
<td>-</td>
</tr>
<tr>
<td>16.</td>
<td>Sulphates (as SO₃) mg/L</td>
<td>222-230.4</td>
<td>227.1 ± 3.675</td>
<td>1000</td>
</tr>
<tr>
<td>17.</td>
<td>Sulphide(as S) mg/L</td>
<td>0.9-1.1</td>
<td>1.1 ± 0.142</td>
<td>2.0</td>
</tr>
<tr>
<td>18.</td>
<td>Phosphate (as P) mg/L</td>
<td>2.4-2.8</td>
<td>2.625 ± 0.17</td>
<td>5</td>
</tr>
<tr>
<td>19.</td>
<td>Iron (as Fe) mg/L</td>
<td>2.2-4</td>
<td>2.225 ± 0.17</td>
<td>-</td>
</tr>
<tr>
<td>20.</td>
<td>Copper (as Cu) mg/L</td>
<td>0.033-0.038</td>
<td>0.036 ± 0.002</td>
<td>3.0</td>
</tr>
<tr>
<td>21.</td>
<td>Zinc (as Zn) mg/L</td>
<td>0.07-0.08</td>
<td>0.07 ± 0.00</td>
<td>1.0</td>
</tr>
<tr>
<td>22.</td>
<td>Chromium (as Cr) mg/L</td>
<td>0.039-0.043</td>
<td>0.041 ± 0.001</td>
<td>2.0</td>
</tr>
</tbody>
</table>

### Table 5: Physico-chemical characteristic of domestic wastewater at S2

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Parameters</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Standard for disposal into inland surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Colour</td>
<td>Light Black</td>
<td>Light Black</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Odour</td>
<td>Unpleasant</td>
<td>Unpleasant</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>pH</td>
<td>7.2-7.4</td>
<td>7.28 ± 0.085</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>4.</td>
<td>TS mg/L</td>
<td>338-345</td>
<td>342.25 ± 3.095</td>
<td>100</td>
</tr>
<tr>
<td>5.</td>
<td>TDS mg/L</td>
<td>738-741</td>
<td>739.5 ± 1.29</td>
<td>2100</td>
</tr>
<tr>
<td>6.</td>
<td>Turbidity (NTU)</td>
<td>80-83</td>
<td>81.5 ± 1.29</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Chloride (as Cl)</td>
<td>415.8-417.4</td>
<td>416.4 ± 0.713</td>
<td>1000</td>
</tr>
<tr>
<td>8.</td>
<td>Oil and Grease mg/L</td>
<td>3.5-4.0</td>
<td>3.775 ± 0.221</td>
<td>10</td>
</tr>
<tr>
<td>9.</td>
<td>Total Kjeldahl Nitrogen(N) mg/L</td>
<td>7.85-8.2</td>
<td>8.012 ± 0.165</td>
<td>100</td>
</tr>
<tr>
<td>10.</td>
<td>Total Hardness mg/L</td>
<td>275-280</td>
<td>277.5 ± 2.018</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Biochemical Oxygen Demand (3 days at 27ºC) mg/L</td>
<td>105-120</td>
<td>114.5 ± 6.557</td>
<td>30</td>
</tr>
<tr>
<td>12.</td>
<td>Chemical Oxygen Demand mg/L</td>
<td>256-272</td>
<td>266.3 ± 7.135</td>
<td>250</td>
</tr>
<tr>
<td>13.</td>
<td>Alkalinity mg/L</td>
<td>55-62</td>
<td>58.75 ± 3.304</td>
<td>-</td>
</tr>
<tr>
<td>14.</td>
<td>Sodium (as Na) mg/L</td>
<td>75-79</td>
<td>77 ± 1.632</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>Potassium( as K) mg/L</td>
<td>24-27</td>
<td>25.6 ± 1.41</td>
<td>-</td>
</tr>
<tr>
<td>16.</td>
<td>Sulphates (as SO₃) mg/L</td>
<td>212.7-215</td>
<td>213.7 ± 1.043</td>
<td>1000</td>
</tr>
<tr>
<td>17.</td>
<td>Sulphide(as S) mg/L</td>
<td>1.1-1.15</td>
<td>1.128 ± 0.022</td>
<td>2.0</td>
</tr>
<tr>
<td>18.</td>
<td>Phosphate (as P) mg/L</td>
<td>1.7-2.1</td>
<td>1.892 ± 0.166</td>
<td>5</td>
</tr>
<tr>
<td>19.</td>
<td>Iron (as Fe) mg/L</td>
<td>2.4-2.5</td>
<td>2.442 ± 0.043</td>
<td>-</td>
</tr>
<tr>
<td>20.</td>
<td>Copper (as Cu) mg/L</td>
<td>0.018-0.028</td>
<td>0.023 ± 0.004</td>
<td>3.0</td>
</tr>
<tr>
<td>21.</td>
<td>Zinc (as Zn) mg/L</td>
<td>0.06-0.06</td>
<td>0.06 ± 0.00</td>
<td>1.0</td>
</tr>
<tr>
<td>22.</td>
<td>Chromium (as Cr) mg/L</td>
<td>0.02-0.031</td>
<td>0.025 ± 0.004</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Table 6: Physico-chemical characteristic of domestic wastewater at S3

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Parameters</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Standard for disposal into inland surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Colour</td>
<td>Light Black</td>
<td>Light Black</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Odour</td>
<td>Unpleasant</td>
<td>Unpleasant</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>pH</td>
<td>7.15-7.2</td>
<td>7.17 ± 0.022</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>4.</td>
<td>TS S mg/L</td>
<td>282-287</td>
<td>285 ± 2.16</td>
<td>100</td>
</tr>
<tr>
<td>5.</td>
<td>TDS mg/L</td>
<td>789-794</td>
<td>791.3 ± 2.217</td>
<td>2100</td>
</tr>
<tr>
<td>6.</td>
<td>Turbidity (NTU)</td>
<td>61-67</td>
<td>64.25 ± 2.5</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Chloride (as Cl)</td>
<td>384-391.2</td>
<td>388.3 ± 3.115</td>
<td>1000</td>
</tr>
<tr>
<td>8.</td>
<td>Oil and Grease mg/L</td>
<td>1.8-3.0</td>
<td>2.5 ± 0.309</td>
<td>10</td>
</tr>
<tr>
<td>9.</td>
<td>Total Kjeldahl Nitrogen(as N) mg/L</td>
<td>7.1-7.3</td>
<td>7.212 ± 0.085</td>
<td>100</td>
</tr>
<tr>
<td>10.</td>
<td>Total Hardness mg/L</td>
<td>283.5-286.7</td>
<td>285 ± 1.363</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Biochemical Oxygen Demand (3 days at 27°C) mg/L</td>
<td>101-114</td>
<td>108 ± 5.477</td>
<td>30</td>
</tr>
<tr>
<td>12.</td>
<td>Chemical Oxygen Demand mg/L</td>
<td>278-292</td>
<td>283.5 ± 6.454</td>
<td>250</td>
</tr>
<tr>
<td>13.</td>
<td>Alkalinity mg/L</td>
<td>60-66</td>
<td>62.75 ± 2.753</td>
<td>-</td>
</tr>
<tr>
<td>14.</td>
<td>Sodium (as Na) mg/L</td>
<td>76-81</td>
<td>78.75 ± 2.217</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>Potassium (as K) mg/L</td>
<td>15-20</td>
<td>17.5 ± 2.38</td>
<td>-</td>
</tr>
<tr>
<td>16.</td>
<td>Sulphates (as SO₃) mg/L</td>
<td>195-207.4</td>
<td>202.8 ± 5.405</td>
<td>1000</td>
</tr>
<tr>
<td>17.</td>
<td>Sulphide (as S) mg/L</td>
<td>0.76-1.12</td>
<td>0.933 ± 0.118</td>
<td>2.0</td>
</tr>
<tr>
<td>18.</td>
<td>Phosphate (as P) mg/L</td>
<td>1.56-2.2</td>
<td>1.827 ± 0.268</td>
<td>5</td>
</tr>
<tr>
<td>19.</td>
<td>Iron (as Fe) mg/L</td>
<td>1.5-1.7</td>
<td>1.6 ± 0.091</td>
<td>-</td>
</tr>
<tr>
<td>20.</td>
<td>Copper (as Cu) mg/L</td>
<td>0.015-0.019</td>
<td>0.017 ± 0.001</td>
<td>3.0</td>
</tr>
<tr>
<td>21.</td>
<td>Zinc (as Zn) mg/L</td>
<td>0.04-0.06</td>
<td>0.05 ± 0.01</td>
<td>1.0</td>
</tr>
<tr>
<td>22.</td>
<td>Chromium (as Cr) mg/L</td>
<td>0.015-0.024</td>
<td>0.019 ± 0.003</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Chemical Oxygen Demand (COD)

COD in all the three stations exceeds the prescribed limit of 250mg/L. Average COD (Fig. 1i) varies between 266.3-310.3. The range varies between 307-313 in S1, 256-272 in S2 and 278-292 in S3.

Alkalinity

Minimum average alkalinity is 58.75 in S2 followed by 62.75 in S3 and maximum value of 73.5 was found in S1 (Fig.1k).

Sodium

Sodium is highly soluble in water and impact softness to water.
Domestic wastewater is the important source of sodium. High concentration of sodium affects the physical conditions of soil (Rawal, 1978). In the present study sodium content varies between 77-82 with an average value of 79 in S1, 75-79 with an average value of 77 in S2 and between 76-81 with an average value of 78.75 in S3. Fig. 1l shows the comparison between the mean sodium values in all the three stations.

Potassium

Potassium plays a major role in the metabolism of water environment. In S1 it varies between 24-27 and average is 25.6 and in S2 the potassium range is between 15-20 with an average value of 17.5. The comparison between the average potassium content in all the three stations are shown in Fig. 1m. Both sodium and potassium are considered to be the plant nutrients that favours the plant growth in an aquatic system.

Sulphates

Sulphate in all the three monitoring stations is within the standard value of 1000mg/L. However, the average sulphate among the three stations is higher in S1 (277.1) which ranges from 222-230.4 followed by S2 (213.7) which ranges from 212.7-215 and lowest is in S3 (202.8) which ranges from 195-
207.4. The comparative values for average sulphate in all the three stations are shown in Fig. 1h.

**Sulphides**

The highest average sulphide of 1.128 with a range of 1.1-1.15 is found in S2 followed by 1.11 with a range of 0.9-1.1 in S1 and 0.933 with a range of 0.76-1.12 in S3. In all the three samples average sulphide is within the prescribed standard of 2mg/L. Fig. 1o shows the comparison of average sulphide values among the different stations.

**Phosphate**

Phosphate is considered as an important plant nutrient. Excess phosphate in aquatic environment contributes towards the eutrophication of water bodies. In the present study, phosphate content in all the three stations are within the standard value of 5mg/L. Phosphate in S1 varies between 2.4-2.8 with an average value of 2.625 which is higher among the three sites followed by 1.892 which varies between 1.7-2.1 in S2 and lowest value was recorded at S3 with an average phosphate content of 1.827 that varies between 1.56 -2.2. Fig. 1p shows a clear picture of comparison between average phosphate content in all the three stations.

**Iron**

The oxides and hydroxides of iron and manganese constitute significant signs of heavy metals into aquatic system. It exists in the soluble ferrous state under reducing conditions. At S1
the iron content in domestic wastewater varies between 2.0-2.4 with the average value of 2.225, at S2 it varies between 2.4-2.5 with the average value of 2.442 and at S3 it varies between 1.5-1.7 with the average value of 1.6. Fig. 1q shows a clear picture of comparison between average iron content in all the three stations.

**Copper**

The standard for disposal for copper is 3 mg/L. Highest average copper of 0.036 which varies between 0.033-0.038 at S1 followed by 0.023 with a range of 0.018-0.028 at S2 and lowest was recorded at 0.017 with a range of 0.015-0.019 at S3. Fig. 1r shows a clear picture of comparison between average copper content in all the three stations.

**Zinc**

In environment zinc occurs primarily in inorganic form, with dissolved or as insoluble complexes and components. It has no known adverse physiological effects upon human beings. It is an essential and beneficial element in human nutrient. In aquatic environment it binds predominantly with suspended materials before finally accumulating in the sediment. In the present study, higher average Zn of 0.07 with a range of 0.07-0.08 was found in S1 followed by 0.6 at S2 and average 0.05 with average of 0.04-0.06 was recorded. This shows that in all the three sites Zn content in wastewater is much below the standard value of 1.0mg/L. Fig. 1s shows a clear picture of comparison between average Zn content in all the three stations.

**Chromium**

Chromium is insoluble in water but soluble in acids is a toxic, non essential metal. It has no biochemical or nutritional function. The prescribed standard is 2mg/L. Out of the three stations studied, higher average chromium was recorded as 0.041 which varies between 0.039-0.043 at S1, 0.025 which varies between 0.02-0.031 at S2 and lowest chromium was in S3 with an average value of 0.019 which varies between 0.015-0.024. Fig. 1t shows the zinc content in all the three stations.

**CONCLUSION**

In the present study, it was observed that, out of the various parameters studied, TSS, BOD, COD values exceeds the prescribed standard for disposal into inland surface water. Some of the parameters like total hardness, alkalinity, TKN, BOD, COD, phosphate, sulphate, sodium, chromium, Zn, Cu were found to be higher in S1 in comparison to other stations. However, parameters like pH, TSS, sulphide, K, oil and grease, Fe are higher in S2. It is suggested that, the domestic wastewater before discharged into outside should be properly diluted or treated in order to reduce its pollution effect on the environment. Since the domestic wastewater contains many essential plant nutrients, through careful study it can be utilized for agricultural purposes.

REFERENCES
