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Removal of water pollutants from the effluent of Tifra industrial area in Bilaspur (C.G.) using bio-adsorbents

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Abstract
Analytical studies of some selected physicochemical parameter with metallic elements were made on the surface water bodies of Tifra industrial areas Bilaspur Chhattisgarh. Water samples were collected from four different selected spots in Mar-April'2018 of Pre-monsoon season, were analyzed for physicochemical and heavy metal like Fe, Zn, Mn and Al by the standard method as per IS procedure. More than 70% of these parameters were above the permissible limit of BIS: 10500 and WHO standard of drinking water. The elevated values of these parameters are of great concern to public health. Removal of water pollutants has been done by preparing bio-adsorbents from local plant origin. Adsorption capacity of different adsorbents has been tested and compared for the removal of various pollutants. The changes in pH, colour, COD, TS, TDS, TSS, TA, TH, Chloride, Fluoride, Sulphate, Nitrate, Phosphate, Ca, Mg, Na, K and heavy metals e.g., Cu, Zn, Fe, Al etc. have been observed

Keywords: Industrial effluent, physico-chemical parameter, water quality, public health and bio-adsorbent

1. Introduction
Water is the most valuable component for the survival of life. Pure drinking water resources are dwindling due to deforestation, mining and industrialization. Approximately 71% of the earth surface is covered with water, mainly in the form of oceans. The actual fresh water is available for human consumption is around 1% of the total earth water. Ground and surface water used by man are of different characteristics. Ground water contains dissolved minerals from the soil layers through which it passes [1-3]. Owing to natural weathering and anthropogenic activities all these parts of universe has been deteriorated the water quality. Moreover, considerable part of this limited quantity of water is polluted by sewage, industrial wastes and a wide array of synthetic chemicals. Thus, the quality as well as the quantity of clean water supply is of vital significance for the welfare of mankind [4-7].

1.1 Study area
Bilaspur city is the district head quarter of Bilaspur district, is the second largest city of Chhattisgarh state. It is situated on the banks of river Arpa. Bilaspur district is located between 21°47´ to 23°08´ North latitudes and 81°14´ to 83°15´ East latitudes, with a height of 262 meters from the sea level. The average rain fall in this area is 1220 mm. Many companies big small have their manufacturing or production units are located in an around Bilaspur. Due to huge industrialization of Bilaspur city and its surrounding air, water and soil are continuously polluted, so it is necessary to analyze the extent of pollutant present in the water of this area [8-9]. The main causes for the deterioration of water quality in water bodies are entering of pollutants due to discharge of untreated or partially treated waste water from these industries, municipal sewage and domestic effluents, so it is necessary to analyze the extent of pollutant present in the water of this area. In this present paper we have presented the analysis of water quality in Mar-April'2018 of pre-monsoon season in reference of physicochemical parameters and explored removal techniques of water pollutants by locally based bio-adsorbents.

2. Material and Method
In order to determine the water chemistry, four surface water samples were collected in a plastic high density polyethylene jerry canes of two liter capacity (one for physical, chemical analysis, metal analysis and another for treatment with bio-adsorbents) previously soaked with 8M HNO_3 and clean with detergent followed by rinsing with double distilled water in the

month of Mar-April'2018 of pre monsoon season. The surface water samples were collected Azad Nagar (TS_1) and Nullah near DPS School (TS_2) nearby the Bilaspur, Tifra industrial area, are shown in Fig.1. The collected water sample was preserved in ice cooled chamber and kept in dark room [10-11]. Analysis was carried out by the standard protocol [10-20] as per standard method within a short period of time, so as to get more reliable and accurate results. *In situ* measurements like Temperature, pH, EC, Turbidity, TDS etc. were measured by Water analyzer kit and colour was measured by visual comparison method. TS and TSS were measured gravimetrically. Cl^-, TH, TA were measured by titrimetrically, Dissolved oxygen was measured by DO meter, COD by digestion and BOD in an incubator. The anions (F^-, NO_3^-, PO_4^{3-} and SO_4^{2-}) were analyzed by spoctrophotometrically. The major cations were measured by flame photometer. Trace elements namely Fe, Zn, Mn, Al were analyzed by Atomic Absorption Spectroscopy. The values of physico-chemical parameters of surface waters are given in Table 1.

Bio adsorbents were prepared in the laboratory with the help of fresh dried wood of *Acacia nilontica* and *Cassia siamea* by activating in muffle furnace at a moderate temperature. The Polluted water samples are fed into the bio-adsorbents by column operation techniques [21-25]. Physico-chemical analysis of the treated effluents were done after running off through the column to compare the untreated effluents by water quality monitoring agencies like WHO (2011) and BIS (2012) which are tabulated in Table 1 & 2.

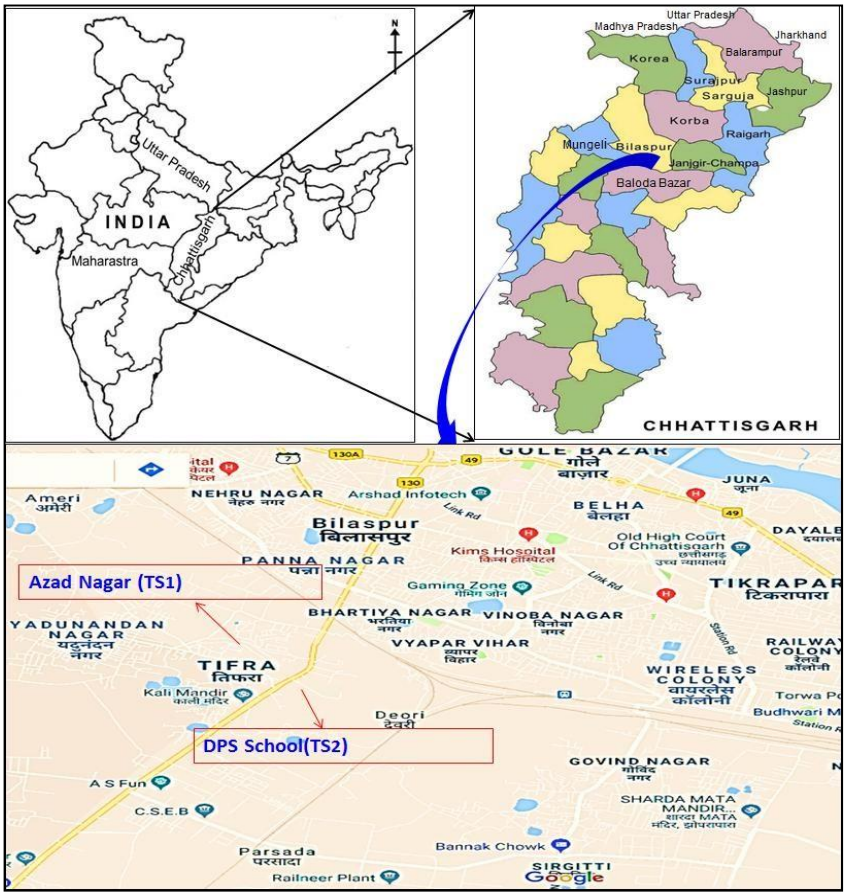

Fig 1: Location of study area

3. Result and Discussion

The results of physicochemical parameters such as Colour, Temperature, pH, EC, Turbidity, Total Solid (TS), Total Dissolve Solid (TDS), Total Suspended Solid (TSS), Total alkalinity (TA), Total Hardness (TH), Chloride, Fluoride, Sulphate, Nitrate, Phosphate, Dissolved oxygen (DO), Biochemical Oxygen demand (BOD), Chemical Oxygen Demand (COD), Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Zinc, Aluminum and WQI for various Surface water samples collected in month of Mar-April' 2018 from two sites around Tfra industrial area, Bilaspur. The untreated and treated effluents with different water quality standards e.g., BIS (2012) and WHO (2011) are given in the Table-1 and II respectively.

The obtained result of all the samples pH are in the range of 7.46 to 7.65, Colour are in the range of 9 to 10 Hazen, EC are in the range of 1224 to 1339 µs/cm, Turbidity are in the range of 23 to 25 NTU, TS are in the range of 894.53 to 904.46 mg/L, TDS are in the range of 760.33 to 812.84 ppm, TSS are in the range of 91.62 to 134.2 mg/L, Total Alkalinity are in the range of 434 to 473 mg/L, Total hardness are in the range of 385 to 496 ppm, Chloride are in the range of 570.82 to 634.42 mg/L, Fluoride are in the range of 1.05 to 1.15 mg/L, Sulphate are in the range of 562 to 635 ppm, DO are in the range of 3.7 to 4.7 ppm, BOD are in the range of 4.42 to 4.72 ppm, COD are in the range of 30.12 to 32.3 ppm, Nitrate are in the range of 50.25 to 52.7 ppm, Phosphate are in the range of 0.09 to 0.13 ppm, Sodium are in the range of 262.3 to 268 ppm, Potassium are in the range of 25 to 26 ppm, Calcium are in the range of 248.8 to 252.42 ppm. Magnesium are in the range of 35.4 to 35.7 ppm. Iron are in the range of 3.1 to 3.35 ppm. Manganese are in the range of 0.13 to 0.15 ppm. Zinc are in the range of 0.22 to 0.49 ppm. Aluminum are in the range of 0.59 to 1.12 ppm and WQI are in the range of 121.20 to 122.

Table 1: Physico-chemical constituents and WQI analysis of different water samples

Parameters/ Sampling Spot	TS_1	TS_2	Indian Drinking water Std. IS 10500: 2012	WHO Rec. 2011
Colour	9	10	5 Hazen	15 TCU
Temperature	30.5	30.3	-	27-28
pH	7.65	7.46	6.5-8.5	6.5-8.5
Conductivity	1224	1339	750-2250	400-2000
Turbidity	25	23	5-8 NTU	5 NTU
TS	894.53	904.46	520-2050	500-1500
TDS	760.33	812.84	500-2000	500-1500
TSS	134.2	91.62	20-50	-
Alkalinity	434	473	300-600	200-600
Total Hardness	496	385	300-600	100-500
Chloride	634.42	570.82	200-1000	200-1000
Fluoride	1.05	1.15	1-1.2	1-1.5
Sulphate	562	635	200-400	200-600
D.O	3.7	4.7	5	5-6
BOD	4.42	4.72	5	5
COD	32.3	30.12	10	10
Nitrate	50.25	52.7	45	50
Phosphate	0.09	0.13	0.1	0.1
Sodium	262.3	268	75-200	200
Potassium	25	26	10	25
Calcium	252.42	248.8	75-200	25-200
Magnesium	35.4	35.7	30	30
Iron	3.1	3.35	0.3-1.0	0.3-1.0
Manganese	0.15	0.13	0.1 - 0.3	0.5
Zinc	0.49	0.22	5	3
Aluminium	1.12	0.59	0.03 - 0.2	0.2
WQI	122	121.200	50-75	-

* All parameters in mg/L except Colour (Hazen), Conductivity (µ mhos/cm), Turbidity (NTU) pH and WQI
TS_1– Azad Nagar and TS_2– Nullah near DPS School.

Table 2: Average value of physicochemical characterization of treated and untreated effluents with bio-adsorbents

Parameters	Untreated effluents	Treated effluents with bio-adsorbents			
		Acacia nilontica	Adsorption Capacity (%)	*Cassia siamea*	Adsorption Capacity (%)
Colour	9.50±1.29	3.09±0.61	68.21	3.50±0.94	63.16
Temperature	30.40±0.13	29.2±0.50	-	29.65±0.30	-
PH	7.56±0.54	7.03±0.05	-	7.10±0.08	-
Conductivity	1,281.50±182.17	494.30±1.50	62.65	524.50±2.00	59.85
Turbidity	24.00±3.42	5.00±2.12	83.33	5.60±1.74	77.50
TS	899.50±71.78	246.17±0.68	74.85	283.60±1.28	69.63
TDS	786.59±110.33	104.44±0.52	86.23	140.22±0.14	82.43
TSS	112.91±43.72	18.70±2.00	85.56	19.32±1.90	83.28
Alkalinity	453.50±36.84	289.00±2.51	65.93	297.00±1.76	35.61
Total Hardness	440.50±87.78	220.30±1.28	78.62	258.60±1.98	59.50
Chloride	602.62±57.00	186.45±1.50	75.67	198.91±0.90	75.87
Fluoride	1.10±0.09	0.90±0.05	68.18	0.96±0.03	52.73
Sulphate	598.50±109.12	210.40±0.08	79.82	248.00±1.02	61.40
D.O	4.20±0.32	4.87±2.42	51.61	4.30±0.98	52.70
BOD	4.57±0.45	4.92±0.64	49.11	4.54±1.07	47.71
COD	31.21±5.27	9.20±2.28	73.09	10.02±0.04	69.50
Nitrate	51.48±5.53	25.21±1.62	70.28	30.38±2.40	43.12
Phosphate	0.11±0.04	0.08±0.03	63.64	0.10±0.01	45.45
Sodium	265.15±35.08	72.26±1.58	71.99	75.18±0.97	66.74
Potassium	25.50±3.77	8.80±1.04	67.84	9.50±1.30	63.92
Calcium	250.61±47.52	70.98±1.26	72.55	74.16±0.79	65.82
Magnesium	35.55±3.14	23.0±1.48	66.24	26.60±0.84	59.77
Iron	3.23±0.84	0.42±0.08	88.24	0.56±0.24	73.99
Manganese	0.14±0.04	0.09±0.04	78.57	0.1±0.02	64.29
Zinc	0.36±0.13	0.1±0.08	72.22	0.20±0.04	44.44
Aluminium	0.86±0.32	0.03±0.02	97.67	0.05±0.01	65.12
WQI	121.60±7.35	47.36±3.04	-	50.60±2.24	-

* All parameters in mg/L except Colour (Hazen), Conductivity (µ mhos/cm), Turbidity (NTU) pH and WQI

Analysis of Industrial effluents (surface water) gave following parameters: Colour, 10 Hazen; Turbidity, 25 NTU; TSS, 134.2 mg/L; Sulphate, 635 mg/L; DO, 3.7 mg/L; BOD, 4.42 mg/L; COD, 32.3 mg/L; Nitrate, 52.7 mg/L; Phosphate, 0.13 mg/L, Na, 268 mg/L ; K, 26 mg/L; Ca, 252.42 mg/L; Mg, 35.7 mg/L; Fe, 3.35 mg/L; Al, 1.12 mg/L and WQI, 122

which is higher than the permissible limit of BIS (2012) and WHO (2011). DO and BOD level indicate too much water pollutant present in the sampling point which is unsuitable for aquatic life. All the investigating points showed greater than maximum WQI (>100); 76-100 WQI values (very poor water quality); indication of intrusion of pollutants by domestic garbage and industrial effluent which is great concern of health.

Considerably high reduction in all physicochemical parameters was observed when the effluent was treated with activated charcoal form biological sources i.e., bio-adsorbents (Tables 2). Relatively greater efficiency of bio-adsorbent was due to its organophillic character. It has matrix of micro-pore, which yields relatively greater active surface area and thus making it suitable for adsorption [26-28]. However, exact mechanisms governing initial rapid rate for the pollutant removal due to surface adsorption followed by intra-particle diffusion, which appears to be the rate governing steps in this experiment. Besides, phenomenon of adsorption can be attributed to various mechanisms such as electrostatic attraction and repulsion, chemical interaction and ion exchange etc [29-30].

4. Conclusion

The present study has been made to evaluate the pollution load on surface water around the Balco industrial area and its removal techniques by locally based bio-adsorbents. The water qualities were marginally higher than the standard values of drinking water, higher values than the standards means very poor water quality; indication of intrusion of pollutants by domestic garbage and industrial effluent. On the basis of the above experiment, it is found that bio-adsorbent from *Acacia nilontica* act as more potent bio-adsorbent for the removal of hazardous water pollutants from industrial waste water comparative to the *Cassia siamea*.

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