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PRELIMINARY ESTIMATION OF BISPHENOL A IN DIFFERENT WATERS FROM BHUJ CITY OF GUJARAT, INDIA

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Abstract: As an Endocrine disruptor Bisphenol A (BPA) has become well-known for its ubiquitous distribution and toxic effects. However, less is known about levels of BPA in different waters of Gujarat state in India. In the present study, 23 water samples including wastewater, surface water, groundwater, and drinking water samples were analyzed for the determination of BPA. pH, Electrical conductivity (EC), and total dissolved solids (TDS) were measured for all the samples. Sample extraction was performed using solid phase extraction and further quantification was done using Waters Acquity Ultra Performance Liquid Chromatography (UPLC) H-Class interfaced with a Photodiode array (PDA) detector. BPA concentrations among all samples ranged from 14.5–121 µg/L (Median: 46.9 µg/L). The highest concentration was seen in wastewater samples, whereas drinking water samples remained undetected for BPA. More studies about BPA levels in different waters in Bhuj city and Gujarat are recommended.

Keywords: Bisphenol A, Bhuj, Surface water, Wastewater, Gujarat.

I. INTRODUCTION

Bisphenol A (BPA) is an industrial chemical, mainly used as a plasticizer for the manufacturing of polycarbonates and epoxy resins. Several studies have reported the occurrence of BPA in environmental matrices such as surface water (Liu et al., 2017; Suzuki et al., 2004; Yamazaki et al., 2015; Zheng et al., 2019), wastewater (Karthikraj and Kannan, 2017; Lee et al., 2015; Marjeta et al., 2018; Sun et al., 2017), sediments (Chakraborty et al., 2018; Huang et al., 2018; Jin and Zhu, 2016; Liao et al., 2012), and, also in various food products (Cao and Popovic, 2015; Cao et al., 2011; González et al., 2020; Liao and Kannan, 2014). Further, BPA has been detected in various human samples indicating human exposure to BPA via various sources (González et al., 2019; Jin et al., 2020, 2017; Jo et al., 2016; Li et al., 2020). Due to ubiquitous occurrence and reported toxic effects BPA has become well well-known pollutant among researchers, although very little is known about BPA levels in developing countries like India.

Gujarat is the western state of India which is well known for the drastic industrial revolution which resulted in several types of industries along the coast. Among other locations on the western coast, Kachchh district has become of more concern for development after a major earthquake in 2001. Consequently, the wastewater from industries and sewage water from the growing population has become an important issue. Bhuj is a city in the Kachchh district with an estimated metro population of 258,000. There are open drainages and also some canals that receive sewage or municipal wastewater. However, there is a lack of information on the level of pollutants in the surface water of this area. Therefore, the present study aimed to (1) Quantification of BPA using Ultra Performance Liquid Chromatography (UPLC) interfaced with a Photodiode array (PDA) detector (2) To measure pH, Electrical conductivity (EC), and total dissolved solids (TDS) of collected water (3) Determination of BPA in surface water, groundwater, and wastewater of Bhuj city.

II. Materials and Methods

2.1 Chemicals and Standards

Bisphenol A (Himedia, purity ~ 97%) standard was used for the standard preparation. All calibration standards were prepared using HPLC-grade methanol. HPLC-grade methanol, HPLC water, and acetic acid were purchased from Rankem, India. Oasis HLB (Hydrophilic lipophilic balanced) (3cc; 60 mg) cartridges were used for solid phase extraction.

2.2 Sample collection and extraction

Water samples were collected from different locations near Bhuj city. All the samples were collected in new polypropylene (PP) material containers. Wastewater (WW; *n*=11), groundwater (GW; *n*=3), surface water (SW; *n*=6), and drinking water (DW; *n*=3) samples were collected from various locations in Bhuj city. Samples were immediately covered with aluminum foil to minimize loss of BPA due to sunlight exposure. Samples were kept at 2–4˚ C until further analysis.

Table 1: Sample list of analyzed water samples from Bhuj city.

No	Location	Sample ID	pH	EC (µs)	TDS (ppm)
1	Sahyog Nagar	WW1	6.81	444	294
2	Opp. Trimandir	WW2	7.09	1057	684
3	Koduki road, Sanjog Nagar	WW3	7.86	558	370
4	Desalpar lake	WW4	7.00	1228	815
5	Hina Parks Railway station	WW5	7.27	1458	970
6	Near Railway station	WW6	8.82	690	460
7	Near Click Hotel	WW7	7.30	1224	816
8	Nagor road	WW8	8.34	1217	809
9	GIDC Bhuj	WW9	7.03	3130	2080
10	Near BSF Bhuj	WW10	7.88	548	365
11	Bhanushali Nagar	WW11	7.33	1067	715
12	Sarjan Casa residency	GW1	6.79	784	520
13	GIDC Bhuj	GW2	7.15	4120	2590
14	Nagor well	GW3	7.55	2310	1540
15	Major road	SW1	8.00	503	333
16	Hamirsar-1	SW2	7.91	340	224
17	Hamirsar-2	SW3	7.77	468	314
18	Hamirsar-3	SW4	8.00	455	302
19	Hamirsar-4	SW5	8.48	540	360
20	Near Trimandir	SW6	8.13	707	488

Table 1 displayed a total of 23 samples were collected and extracted for BPA analysis. Water samples were loaded to the Oasis HLB solid phase extraction (SPE) cartridge connected with syringe filters (pore size: 5.0 µ) on the cartridge to avoid blockage of the cartridge. The extraction was performed following the method already reported (Lalwani et al., 2020; Yamazaki et al., 2015). Before analysis, all the equipments were washed with Milli-Q and methanol to avoid possible contamination. 100 mL sample volume was used for clean water whereas 2:3 dilution was used for blackish or dirty samples. Before sample loading acetic acid was used to set pH 3. Initially, the cartridge was conditioned using 3 mL methanol followed by 3 mL Milli-Q water. Then the sample was loaded and further cartridge was washed with 3 mL (1 mL× 3) of 5% methanol in Milli-Q water. Cartridges were dried using a vacuum pump for 3 min. Lastly, the target chemical was eluted using 3 mL (1 mL× 3) of methanol. A 10 µL sample was injected into UPLC for the detection and quantification of BPA.

2.3 Instrumental analysis

BPA was analyzed using Waters Acquity Ultra Performance Liquid Chromatography (UPLC) H-Class interfaced with a Photodiode array (PDA) detector. The separation was performed using Acquity BEH C18 column (150 mm × 2.1 mm × 1.7 µ) using the gradient of HPLC water (Solvent A) and Methanol (Solvent B) at 0.3 mL flow rate. The gradient was adjusted as shown in Table 2 after several trials and errors for good peak shape and lower noise level. Detection of BPA was done using a PDA detector at 220–350 nm. The samples were quantified using Masslynx analysis software using the external calibration curve.

Table 2 : LC Gradient parameters for BPA detection

Time (min)	HPLC Water	Methanol
0.00	60	40
0.35	60	40
4.00	10	90
5.00	10	90
5.01	60	40
6.00	60	40

2.4 Quality Assurance and Quality Control (QA/QC)

To ensure an accurate analysis procedural blank and recovery were performed with samples using the same method. BPA was detected in blank at 0.70 µg/L, which was subtracted from the sample results, while mean procedural recovery ranged from 60–103% for BPA. The eight-point calibration curve (0.5–75 µg/L) was injected for BPA, where the deviation (%) was <30% compared to real standard values. The correlation coefficient (r) was 0.997 for the linear calibration curve.

III. Results and Discussion

3.1 Concentration of BPA in water samples of Bhuj

Among 23 samples analyzed from Bhuj city, 16 water samples were detected with BPA. The pH, EC and TDS values for each sample have been summarized in Table 1.

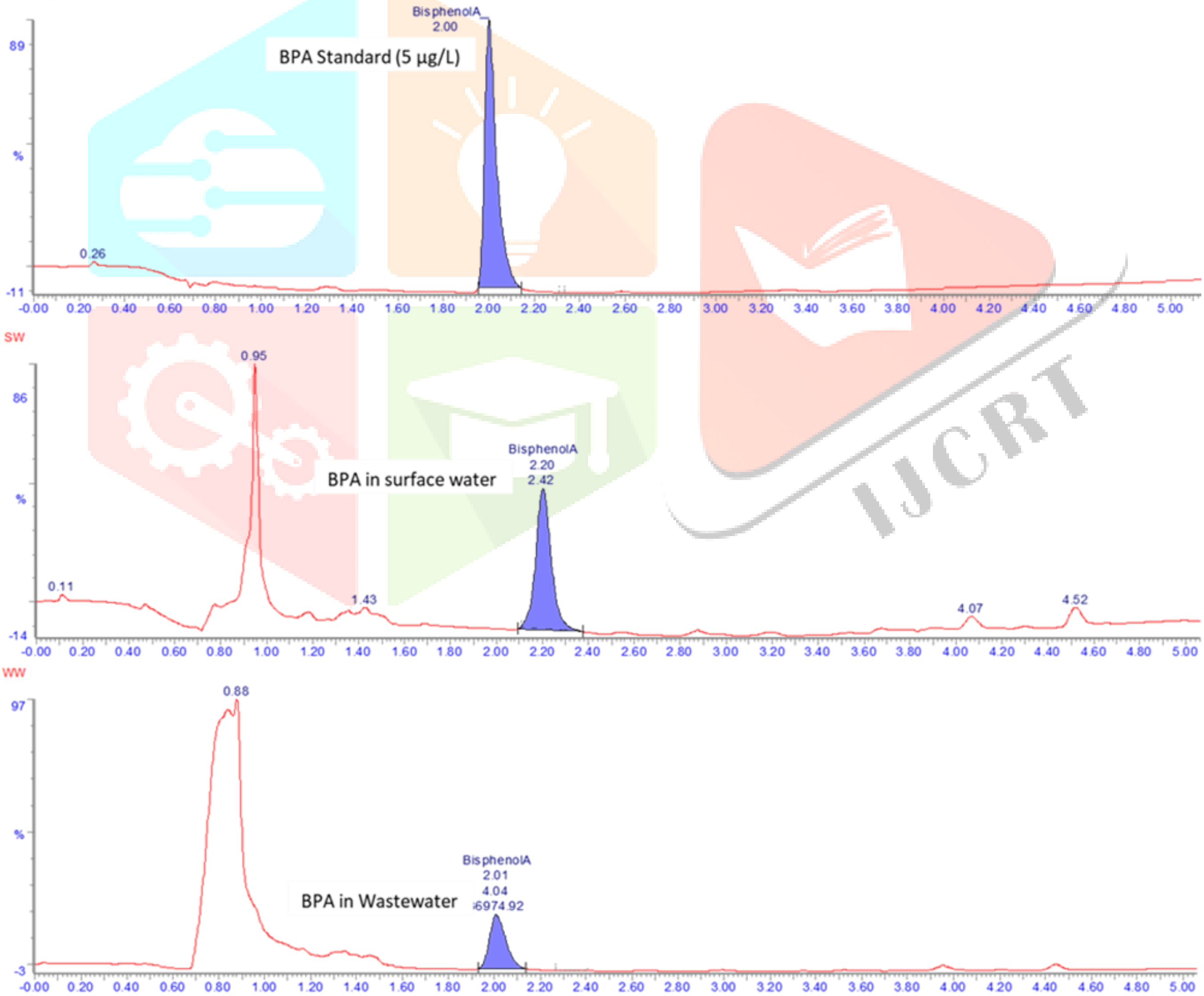

Figure 1. Chromatogram of BPA detection in standard solution, in surface water, and in wastewater sample

The pH for the water samples ranged from 6.79–8.82 whereas EC fluctuated between 340–4120 µs and TDS shown range from 294–2590 ppm. The quantification of BPA was performed using the external calibration curve. The chromatogram of BPA in the standard solution, surface water, and wastewater is shown in Fig. 1. BPA showed a chromatogram at a retention time (RT) of 2.00 min for the 5 µg/L standard solutions, however, for surface water and wastewater samples the RT was shifted to 2.20 min and 2.01 min, respectively.

BPA concentrations in various water samples have been depicted in Fig. 2. BPA concentrations among all samples ranged from 14.5–121 µg/L (Median: 46.9 µg/L). As expected, the lowest concentration of BPA was detected in groundwater while the highest one was observed in wastewater samples near the railway station area of Bhuj city. This might suggest the nearby sources of BPA in the wastewater, which could be sewage waste from nearby populations or waste from consumer products containing BPA. Further, BPA remains undetected in the drinking water used in the city.

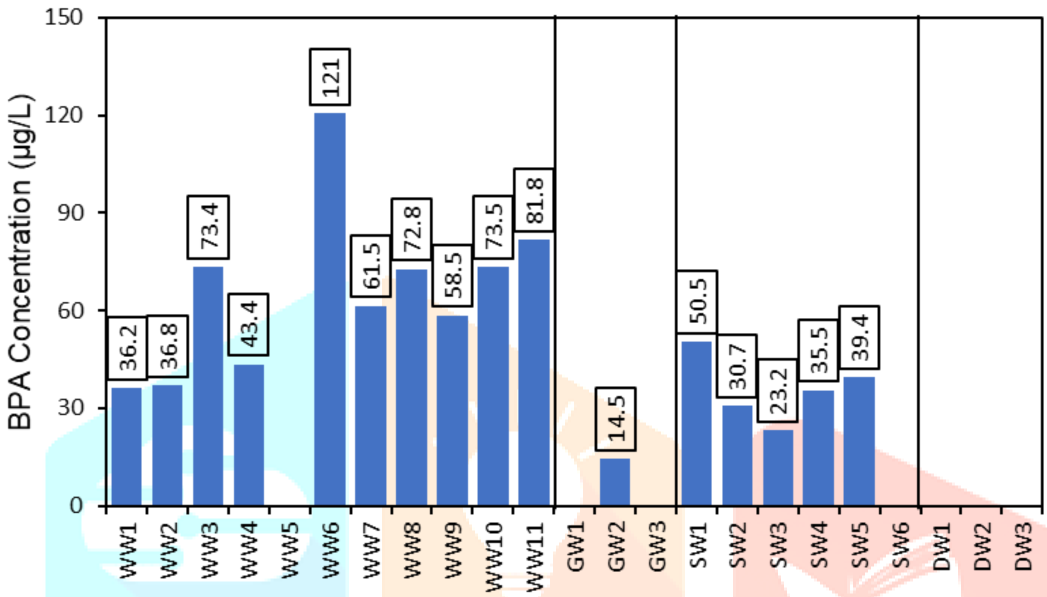

Figure.2. BPA concentration in wastewater (WW), groundwater (GW), surface water (SW), and drinking water (DW) samples from different locations of Bhuj city. No bar means BPA was not detected in that sample.

3.2 Correlation and comparison of BPA

The correlation among BPA, pH, and TDS is shown in Table 3. BPA showed a positive correlation with the TDS of water samples in the present study, which indicates the role of particle-attached BPA in the water samples. Further, pH showed a positive correlation with BPA concentration in the present study, similar to the previous study (Borrirukwisitsak et al., 2012). BPA concentration was on the higher side at the pH range of 7.9–8.8, where the highest BPA (121 µg/L) was detected in a wastewater sample with a pH of 8.82. This might be due to the dissociation of BPA in the water medium around pH 8. No correlation was found between BPA and EC.

Table 3 Correlation of BPA with other measured parameters in this study

	BPA (µg/L)	pH	EC (µs)	TDS (ppm)
BPA (µg/L)	1			
pH	0.4510	1		
EC (µs)	-0.2046	-0.3953	1	
TDS (ppm)	0.2878	-0.3420	0.9996	1

Less is known about BPA in Gujarat, however, in a previous study 289 ng/L BPA has been reported in pond water from Dhrobana village of Kachchh district (Lalwani et al., 2020). Dhrobana village is a comparatively rural area, which might result in lower BPA values than reported in the present study.

Further, another study has reported a high concentration of BPA (n.d.–1,950 ng/L), followed by its new analogues BPS (n.d.–7,200 ng/L) and BPF (n.d.–289 ng/L) in rivers and lakes in Chennai city of India (*n*=14) (Yamazaki et al., 2015). Another study reported BPA in the Kaveri, Vellar, and Tamiraparani rivers of Tamil Nadu District, India (*n*=27), ranging from 2.83–136 ng/L (Selvaraj et al., 2014), which is comparatively lower than found in various waters of Bhuj city. One research from Kachchh has been published about in vitro and silico studies of BPA toxicity (Trivedi et al., 2020). In summary, not only BPA but its new analogues have also been detected in Indian waters, although no data is available for Bhuj city of Gujarat.

IV CONCLUSION

In summary, a total of 23 water samples including wastewater, surface water, groundwater, and drinking water were analyzed for the determination of BPA. Basic parameters pH, EC, and TDS were measured for all samples. pH and EC showed a positive correlation with BPA concentration. The highest level of BPA was observed in wastewater samples of Bhuj City, whereas the lowest value was for Groundwater. BPA was not detected in drinking water in the present study. More detailed studies covering more areas of the city are recommended for further insights in this direction. Especially, researchers can focus on the level of BPA and its new analogues in different waters of Bhuj city and the other areas of Gujarat.

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