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Seasonal variation of Physico-chemical properties of Arpa River in Chhattisgarh

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ABSTRACT

The water of river which is running through industrial area may be contaminated by industrial effluents and the chemical property may be changed due to imbalance of homeostasis among constituents of river water. The sampling was made for over a period of 12 months in different stations. Some of the properties were not changing by the industrial pollution. BOD, COD, TDS and nitrite nitrogen of Arpa River is not changing during the year whereas the pH, Ammonia, Nitrite nitrogen, total solids, dissolved solids, total phosphate, sulphate and total hardness changes during the year.

Keywords: Water, Chemical properties, Industrial effluents, biotic community, Atomic absorption spectroscopy.

INTRODUCTION

Arpa River is a perennial water resource which is a tributary of river Mahanadi in Chhattisgarh. This divides the coalfield area in Bilaspur division into two unequal parts i.e. South Eastern and Mahanadi division Coalfields. Arpa River originates from Khadri, village of Pendra Tehsil of Bilaspur District (C.G.) and flows from North East to South. The river flows through forest land, Crop land and densely populated rural areas Heavy industrialization and increasing population has increased coal utilization in the Bilaspur district. The toxic metals are disposed into the river by iron and ore industries in this area. The Tifra and sirgitti industrial area in Bilaspur district is major producer of fly ash in Chhattisgarh which is mortally disposed into Arpa River [1]. Mine water is acidic in nature and dissolves the toxic elements like Cd and Pb [2]. The water of river which is running through industrial area may be contaminated by industrial effluents and the chemical property may be changed due to imbalance of homeostasis among constituents of river water [3]. Some of the properties of water can accommodate to limited toxic compound present in the industrial effluents but some properties changing due to small amount of toxic effluents. The present study is aimed to analyze the variation of chemical properties of water of Arpa River during year.

MATERIALS AND METHODS

Water sample collection: The sampling points were already fixed for water collection i.e. industrial wastes which are discharged into the river

S_1 = Up-stream

S_2 = Middle Stream

S_3 = Down Stream

The sampling was made for over a period of 12 months in different stations. The sampling was done once in middle of every month. 2.5 liters of water and effluent samples were collected for physico-chemical test and 300 mL water sample was collected in sterilized BOD bottle for biological test. The samples were analyzed within a period of 24 hours and standard method adopted N.Manivasakam [4] , APHA [5] and text book of soil chemical analysis [6]. The physico-chemical parameters of effluent and Arpa river water were determined.

RESULTS

The present study analyzed the seasonal variation of physico chemical properties of Arpa River from the selected sites and the results are presented.

pH : In effluent station S_1 pH was found to range from 7.21 to 8.40, to S_2 was, 6.50 to 7.98 and for $S_3$7.12 to 8.30 (Table 1) . Minimum pH value was recorded in April in station S_1 but maximum pH was recorded in June for S_1. Statistically Significant difference ($P<0.0001$) was indicated amongst the three sampling stations and the corresponding monthly values by two way variance analysis test. fig 1 showing graphical representation of seasonal variation of pH in water.

Table -1 Monthly Variation in pH at Three Sampling Station in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	8.10	6.91	7.70
August	8.00	6.56	7.78
September	7.48	6.50	7.78
October	7.71	6.78	8.00
November	8.00	6.72	8.00
December	7.98	7.20	8.16
January	7.94	7.98	8.30
February	7.46	7.25	8.10
March	7.58	7.52	7.56
April	7.21	7.46	7.51
May	8.00	7.00	7.83
June	8.40	7.00	7.12
ANOVA		$R^2 = 0.5007$	
		$P<0.0001$	

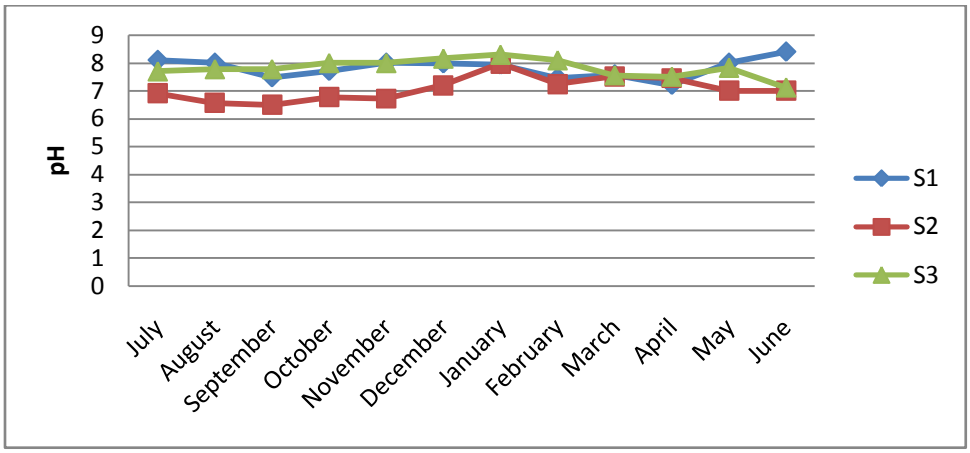

Fig1. Graphical representation of seasonal variation of pH in water of Arpa river throughout the year.

Total Solid concentration in water: In water monitoring station from S_1 to S_3 and river water station from S_1 to S_3, Total Solids were found in presented in table-2. Total solid to vary from 225 mg L^{-1} to 740 mg L^{-1}. In effluent water total solids ranged for station S_1 352 mg L^{-1} to 540 mg L^{-1}, for station S_2 225 to mg L^{-1} to 534 mg L^{-1} for station S_3 504 to 740. Minimum total solids concentration was observed in February for station S_1 , but maximum was observed in June S_2. S_3 has highest values throughout the year as compared to the values for other stations. For upstream of Arpa River, the total solid value was found minimum as 352 mg L^{-1} to maximum 540 mg $L^{-1}$and for downstream of Arpa river. Total solid was 504 mg L^{-1} to maximum 740 mg L^{-1}.

Table -2 Monthly Variation of Total Solids (mg L^{-1}) at three Sampling Stations in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	410	534	605
August	464	472	600
September	470	490	614
October	462	486	540
November	460	430	570
December	394	412	504
January	398	406	614
February	352	317	500
March	352	225	620
April	426	474	688
May	58	370	700
June	5-0	400	740
ANOVA		$R^2 = 0.5174$ P<0.0001	

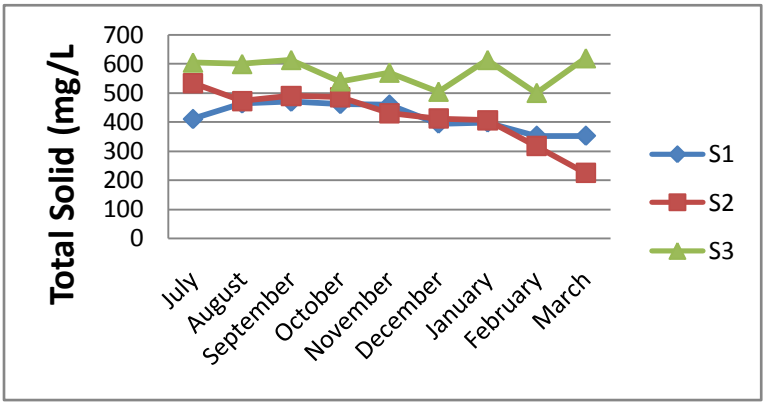

Fig 2. Graphical representation of seasonal variation of total solids of Arpa river throughout the year

Total dissolved solids in water: The results of concentration of total solids in water of Arpa River in different months are given table-3. Minimum total dissolved solids are obtained in January for station S_1 but maximum were observed in March for station S_2, S_3 has highest values throughout the year in comparison to the values for other stations. The concentration of total solids in the water was found statistically insignificant (P = 0.0509) during different months of year as well as in different sites of water in river.

Table 3. Monthly Variation of total dissolved solids (mg L^{-1}) at three Sampling Stations in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	220	330	398
August	223	348	394
September	264	310	350
October	258	290	310
November	280	234	290
December	245	412	300
January	207	312	382
February	243	207	290
March	285	228	220
April	278	230	239
May	278	185	204
June	282	298	430
ANOVA		R^2 = 0.1651	
		P = 0.0509	

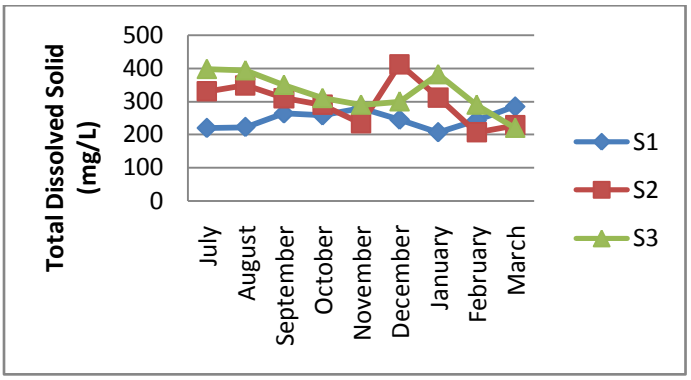

Fig 3. Graphical representation of changes in TDS of water of Arpa River throughout the year

Chloride concentration: Chloride content was found to vary from 9.0 to 17.0 mg L^{-1} for S_1 effluent station and 9.99 to 24 mg L^{-1} for S_2 and S3 in river water stations (table 4). In effluent water total chloride varied for station S1 9.0 mg L^{-1} to 17.0 mg L^{-1}, for station $S_2$10.99 mg L^{-1} to 24 mg L^{-1}, for station S 9.99mg L^{-1} to 20 mg L^{-1}. Minimum chloride were obtained in month of August for station S_1 but maximum were observed in the month of June for station S_2. S_3 has highest values throughout the year as comparatively values for other stations. The distribution of chloride in Arpa river throughout the year was not changed significantly and the P value from ANOVA was found P = 0.0678, insignificant for chloride in water. Fig 4 showing the variation of concentration of chloride in the Arpa River.

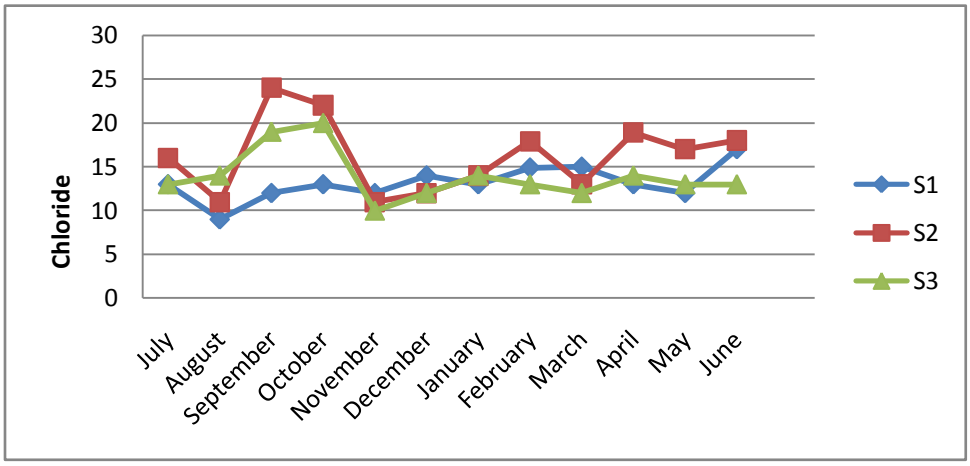

Fig 4. Graphical representation of seasonal variation of BOD of Arpa river throughout the year.

Table 4. Monthly Variation in Chloride (mg L^{-1}) at Three Sampling Stations in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	13	16	13
August	9	11	14
September	12	24	19
October	13	22	20
November	11.99	10.99	9.99
December	14	12	12

January	13	14	14
February	14.9	17.9	13
March	15	13	12
April	13	18.9	14
May	12	17	13
June	17	18	13
ANOVA		$R^2 = 0.1505$	
		P = 0.0678	

Biological Oxygen Demand (BOD**) :** The biological oxygen demand of water of Arpa River was not found differentially distributed during the different moths of year. BOD was found to vary from 5.8 to 13.8 mg L^{-1} for S_1 to S_3 effluent stations. The study found differences in BOD of water of Arpa River which is presented table-5 were statistically insignificant and the P value was found 0.0634 for BOD in this water. The fig-5 showing the differences in BOD of water of Arpa River.

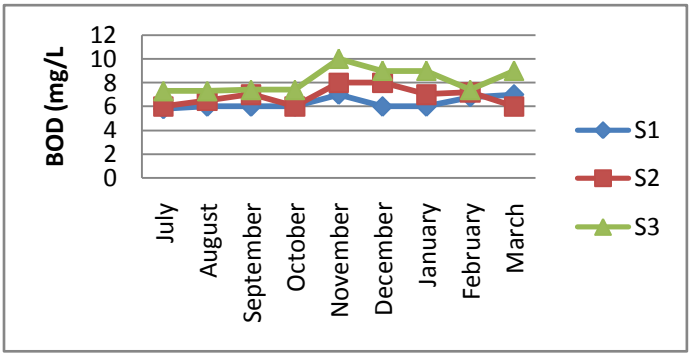

Fig-5 Graphical representation of seasonal variation of BOD of Arpa river throughout the year.

Table 5. Monthly Variations in Biological Oxygen Demand (BOD) (mg L^{-1}) at three sampling Stations in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	5.8	6	7.3
August	6	6.5	7.3
September	6	7	7.4
October	6	6	7.4
November	7	8	10
December	6	8	9
January	6	7	9
February	6.8	7.2	7.4
March	7	6	9

April	6	5	7.3
May	10.3	12	13.8
June	10	10	9
ANOVA		$R^2 = 0.1540$	
		P = 0.0634	

Chemical Oxygen Demand (COD) : The variation in COD of water of Arpa River is given table-6. COD was found to vary from 54 to 98 mg L^{-1} for S_1 to S_3 effluent stations. The ANOVA value was found insignificant (0.4971) for COD. Fig-6 showing graphical representation of COD.

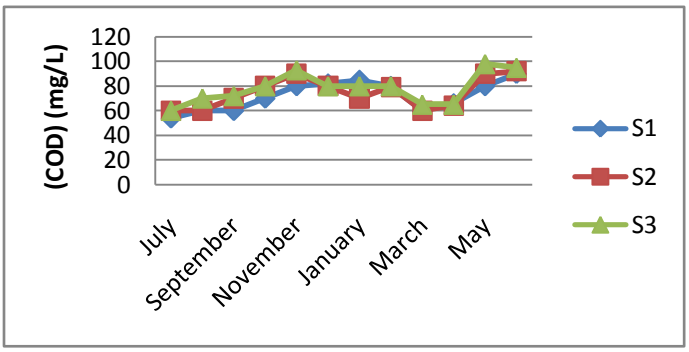

Fig-6 Graphical representation of seasonal variation of COD of Arpa river throughout the year.

Table 6. Monthly Variations in Chemical Oxygen Demand (COD) (mg L^{-1}) at Three Sampling Stations in Arpa River.

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	54	60	60
August	60	60	70
September	60	70	72
October	70	80	80
November	80	90	93
December	82	80	80
January	85	70	80
February	80	79.2	80
March	60	60	65
April	66	64	65
May	80	90	98
June	90	92	95
ANOVA		$R^2 = 0.04148$	
		P = 0.4971	

Ammonia (NH3): The variation of ammonia concentration in water of Arpa River is presented in table-7. The present study was found statistically significant (P = 0.0002) value of ANOVA. Fig-7 showing the Ammonia (NH3) was found to vary from 0.40 to 1.4 mg L^{-1} for S_1 to $S_{3..}$

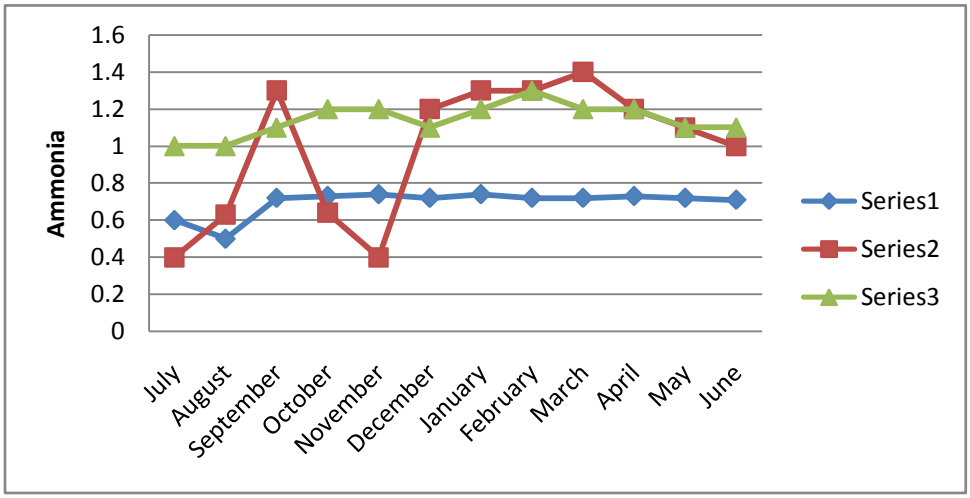

Fig 7. Graphical representation of seasonal variation of Ammonia of Arpa river throughout the year.

Table-7 Monthly Variation in Ammonia (NH3) (mg L^{-1}) at three Sampling Stations in Arpa River during July 2012 to June 2013

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	0.60	0.40	1.00
August	0.50	0.63	1.00
September	0.72	1.3	1.10
October	0.73	0.64	1.20
November	0.74	0.40	1.20
December	0.72	1.20	1.10
January	0.74	1.30	1.20
February	0.72	1.30	1.30
March	0.72	1.40	1.20
April	0.73	1.20	1.20
May	0.72	1.10	1.10
June	0.71	1.00	1.10
ANOVA		$R^2 = 0.4229$ P = 0.0002	

Nitrate Nitrogen (NO_3- N) : The results of nitrate ammonia in the water of Arpa River showing in table-8 and its graphical representation in fig-8. The nitrate Nitrogen in the water was not found statistically

significant. The P value was found P = 0.4284 for Nitrate Nitrogen (NO_3-N)is insignificant. The values range from 0.80 to 1.8 mg L^{-1} for S_1 to S_3.

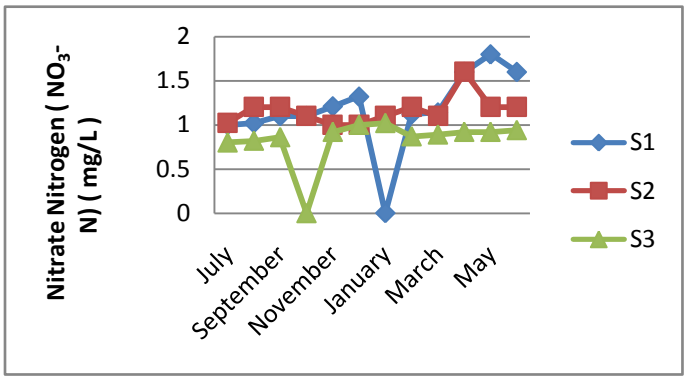

Fig-8 Graphical representation of seasonal variation of Nitrate Nitrogen of Arpa river throughout the year.

Table 8. Monthly Variation in Nitrate Nitrogen (NO_3- N) (mg L^{-1}) at Three Sampling Stations in Arpa River

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	1.00	1.02	0.80
August	1.02	1.20	0.82
September	1.10	1.20	0.86
October	1.10	1.10	0,82
November	1.21	1.00	0.92
December	1.32	1.00	1.00
January	1.2.1	1.10	1.02
February	1.12	1.20	0.87
March	1.14	1.10	0.89
April	1.60	1.60	0.92
May	1.8	1.20	0.92
June	1.60	1.20	0.94
ANOVA		R2 = 0.05160 P = 0.4284	

Nitrite Nitrogen (NO_2-**N) :** Nitrite Nitrogen concentration in the Arpa river was significantly changed during the year. Nitrite Nitrogen (NO_2-N) was found to vary from 0.08 to 0.76mg L^{-1} for S_1 to S_3.

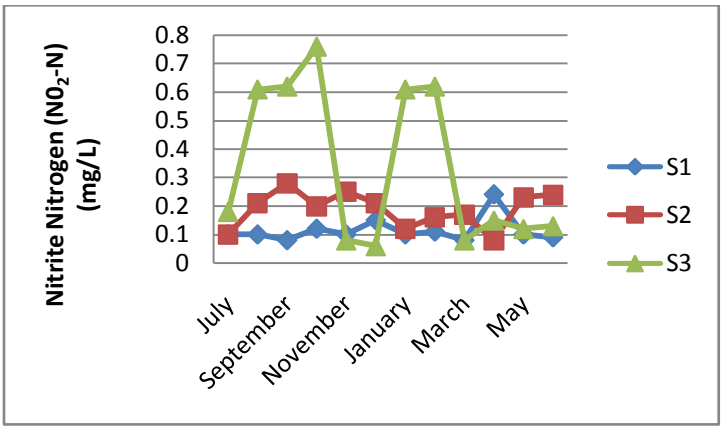

Fig-9 Graphical representation of seasonal variation of Nitrite Nitrogen of Arpa river throughout the year.

Table 9 - Monthly variation in Nitrite Nitrogen ($N0_2$-N) (mg L^{-1}) at three Sampling Stations in Arpa River.

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	0.10	0.10	0.18
August	0.10	0.21	0.61
September	0.08	0.28	0.62
October	0.12	0.20	0.76
November	0.10	0.25	0.08
December	0.15	0.21	0.06
January	0.10	0.12	0.61
February	0.11	0.16	0.62
March	0.08	0.17	0.08
April	0.24	0.08	0.15
May	0.10	0.23	0.12
June	0.09	0.24	0.13
ANOVA		R2 = 0.2500 P = 0.0087	

Phosphate (PO_4^{-3} %) : The results of phosphate concentration in the Arpa river is presented in the table-10. This study was found statistically insignificant variability of phosphate concentration during the year. The concentration of Phosphate (PO_4^{3-}) was found to ranges from 0.10 to 1.72 mg L^{-1}. for S_1 to S_3 effluent stations. fig 10 showing the phosphate concentration of Arpa River in three different sites.

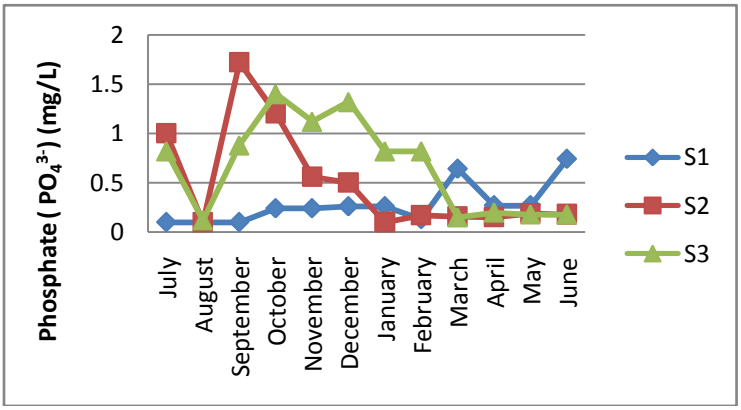

Fig-10 Graphical representation of seasonal variation of Phosphate of Arpa river throughout the year.

Table -10 Monthly Variations in Phosphate (PO_4^{3-}) (mg L^{-1}.) at three Sampling Stations in Arpa River.

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	0.10	1.00	0.82
August	0.10	0.10	0.12
September	0.10	1.72	0.88
October	0.24	1.20	1.40
November	0.24	0.56	1.12
December	0.26	0.50	1.32
January	0.26	0.10	0.82
February	0.13	0.17	0.82
March	0.64	0.16	0.15
April	0.27	0.15	0.20
May	0.27	0.19	0.18
June	0.74	0.18	0.18
ANOVA		R2 = 2.463 P = 0.1007	

Sulphate (SO_4^{2-}) : Sulphate (SO_4^{2-}) was found to vary from 32 to 81 mg L^{-1}. for S_1 to S_3 effluent stations (table-11). Sulphate concentration was found statistically insignificant in this study. Fig-11 showing the changing of concentration of Sulphate in the Arpa River.

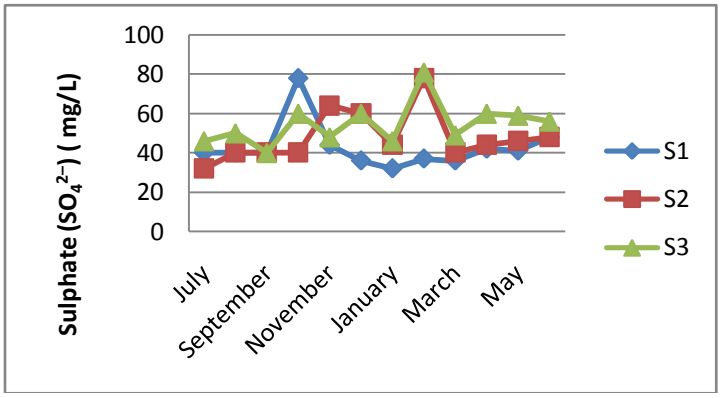

Fig-11 Graphical representation of seasonal variation of Sulphate of Arpa river throughout the year.

Table -11 Monthly Variation in Sulphate (SO_4^{2-}) (mg L^{-1}) at three Sampling Stations in Arpa River.

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	40	32	46
August	40	40	50
September	40	40	40
October	78	40	60
November	44	64	48
December	36	60	60
January	32	44	46
February	37	78	81
March	36	40	49
April	42	44	60
May	41	46	59
June	48	48	56
ANOVA		R2 = 0.1519 P = 0.0660	

.

Total Hardness: The results of total hardness are given in table-12. Total Hardness was found to vary from 30 to 78 for S_1 to S_3 effluent stations. Total hardness is not fond significantly changed during the year. Fig-12 representing changes in total hardness of water during the year.

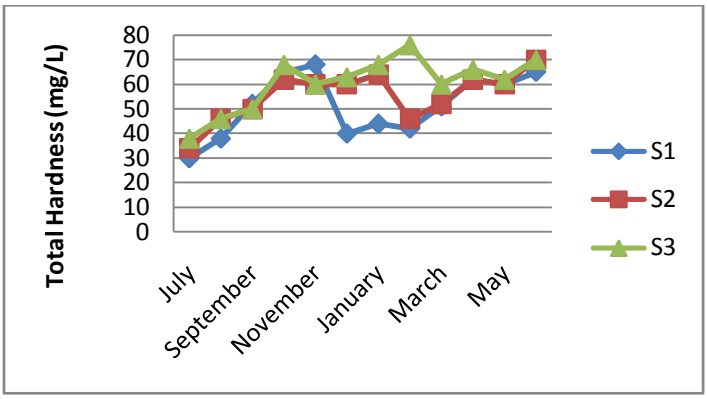

Fig-12 Graphical representation of seasonal variation of Total Hardness of Arpa river throughout the year.

Table 12. Monthly Variations in Total Hardness (mg L^{-1}) at three Sampling Stations in Arpa River.

Months	**River water stations**		
	S_1	**S_2**	**S_3**
July	30	34	38
August	38	46	46
September	52	50	50
October	65	62	68
November	68	60	60
December	40	60	63
January	44	64	68
February	42	46	76
March	51	52	60
April	62	62	66
May	60	60	62
June	65	70	70
ANOVA		$R^2 = 0.1084$	
		P = 0.1507	

DISCUSSION

pH of water is essential factor for maintaining appropriate composition of water. When the pH changing sharply the biotic composition of water changes and the process of decomposition of organic materials of water reduces. The findings of this study is similar with Yadav et al. [7]. Total solids and dissolved solids are the parameter of presence of minerals in the water. The total solids and dissolved solids concentration was significantly changed during the year. The industrial effluents desposes several toxic compound in to the water which changes the dissolved solids in the water. Chloride concentration is not changing during the year. The biological oxygen demand is the requirement of oxygen by biotic community of for decomposition of organic toxic compound [8, 9, 10]. The differences in BOD of water are insignificant during the year but some of the months of year BOD was found in very low level in this study. There are several studies which found similar results with this study [11,12]. Chemical oxygen demand is found insignificant in this study the results are similar with several studies [13,14]. The COD is not sharply changing during the year in Arpa River. The sulphates and phosphates are essential components of water

and which maintain acidity and affect the other properties of water. In the present investigation the effect of industrial effluent changes the concentration of sulphate and phosphate of the river water these findings are similar with several studies [15,16,17]. Water hardness is influencing with the industrial effluents in this study and the several other studies made agreement with this study [18,19].

APPLICATIONS

These studies are useful for knowing the quality of water quality parameters.

CONCLUSIONS

The water of Arpa River is changing during the year. The several chemical properties influenced by industrial effluents and made the water toxic. Some of the properties were not changing by the industrial pollution. BOD, COD, Ammonia, Nitrate nitrogen and Nitrite nitrogen of Arpa River is not changing during the year whereas the pH, total solids, dissolved solids, total phosphate, sulphate and total hardness changes during the year.

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