



Physico-chemical Studies on Kamla River Water

Ravindra Kumar*, Arvind Kumar Jha
Department of Botany, C. M. Science College,
Darbhanga, Bihar, India

Abstract: Water of Kamla river between stretch of Jaynagar and Jhanjharpur was studied for pollution load by determining various water quality parameters, for all four seasons viz. winter, spring, summer & rainy seasons. The river is subjected to severe domestic, agricultural and small factories pollution at Jaynagar. The polluted water is carried down stream to Jhanjharpur. The study revealed that pH range is 7.5-8.6. Organic pollution is mild as indicated by DO (4.4 to 7.3 mg/l) and BOD (4.8 to 10.9mg/l). But the value of COD ranges between 29.4 mg/l to as high as 71.8 mg/l. The TDS ranges from 950 to 1230 mg/l. To monitor water quality samples from six stations were collected seasonally. The water around Jaynagar was highly polluted. In this paper results of one year study are presented.

Keywords: COD, TDS,

I. INTRODUCTION

The river **Kamla** originates from **Mahabharat range** of hills in Nepal near **Sindhuliagarhi** at an elevation of **1200 metres (3900 ft.)** at the latitude **27°15' N** and longitude **85°57' E**. It enters Indian territory in the district of **Madhubani** in Bihar, 3.5 Km upstream of **Jaynagar town**. A barrage known as Kamla barrage has been constructed by the state Government near Jaynagar. It joins the river **Kareh (Bagmati)** at **Badlaghat** in **Khagaria district** and the combined stream flows into the nearby **Koshi**. While one of its branches leads to the **Bagmati** another leads to the Kosi. In the lower reaches it follows the course of the Balan and is therefore also known as **Kamala-Balan**. The total length of the river Kamla – Balan is **328 Km** of which **208 Km** is in Nepal and the remaining **120 Km** is in India. The river Kamla – Balan drains a total catchment area of **7232 Sq Km**. Out of this **4488 Sq Km** lies in Bihar state of India and the remaining **2744 Sq Km** in Nepal.

MAP OF INDIA



MAP OF BIHAR



MAP OF MADHUBANI DISTRICT



MAP SHOWING KAMLA RIVER (STUDY AREA)

↑ (NORTH)

↓ Kamla river



FIGURE-1 STUDY AREA LOCATION MAP

Water pollution is an acute problem in all the major rivers of India. Due to increasing urbanization and human activities, the pollution level of river Kamla is increasing day by day. Six samples were collected from different places between Jaynagar and Jhanjharpur. Water samples were analysed with an aim to study the physical and chemical characteristics to investigate the factors responsible for causing water pollution. Household sewage, small factory effluents, fertilizers and pesticides discharged from farms are main reasons of river water pollution (**Simpi ,B. et al., 2011**).

II. MATERIALS AND METHODS

Midstream surface water samples were collected for analysis from six sampling stations. The samples were collected in wide mouthed polythene bottles and stored in ice box for further analysis after determining temperature, pH and electrical conductivity. The samples were analyzed for following physico-chemical parameters viz., **Temperature** (by mercury thermometer), **pH** (by using pH meter), **Alkalinity** (by titration method with the help of pH meter and diluted **H₂SO₄**), **Hardness** (EDTA Titrimetric method), **Turbidity** (Nephelometric Method) , **Electrical Conductivity** (by using conductivity cell potentiometric meter), **Sulphate** (by the Nephelometry method), **Chloride** (by Mohr's argentometric method using Potassium chromate as indicator), **Phosphate** (Stannous chloride method), **Nitrate** (using the Phenol disulphonic acid colorimetric test Jackson), **Dissolved oxygen** (Winkler method with acidic modification), **Biochemical Oxygen Demand** (by incubating diluted sewage samples at 25°C for 5 days in dark), **Chemical Oxygen Demand** (by dichromate reflux method using a ferron indicator) & **Total dissolved solids** (Gravimetric after filtration). Most of the physico-chemical parameters were determined by standard methods prescribed by **APHA (2005)**.

III. RESULTS AND DISCUSSION

Physico-chemical properties of river Kamla in different seasons and at different stations are as follows -

Temperature

Temperature is the important factor which influences the chemical, biochemical and biological characteristic of the aquatic system (**Kumar R. et al, 2005**).The present investigation reveals that the temperature varied from minimum **20.6 ac** in winter near NH-104 bridge, Jaynagar and Kuarpatti to maximum **31.8 ac** in summer near Kali Mandir and old Durga Mandir, Jaynagar. The temperature values were significantly higher in summer.

pH

pH is most important in determining the corrosive nature of water. Lower the **pH** value higher is the corrosive nature of water. **pH** was positively correlated with electrical conductance and total alkalinity (**Gupta, 2009**). As most of the chemical and biochemical reaction are influenced by the **pH** it is of great practical importance. The adverse affect of most of the acids appear below **pH 5** and of alkalis above the **pH 9** (**Kriest & Oshlies, 2013**). The **pH** values were significantly higher from end of the summer to beginning of the winter with the highest value **8.6** in winter near old Durga Mandir and Navtoli and lowest value **7.5** in summer near old Durga Mandir, Jaynagar.

Alkalinity

Alkalinity constitutes an important parameter in determining the quality of water (**Giri & Singh , 2014**). A variation in alkalinity values were recorded as a minimum of **200 mg/l** in rainy near Kuarpatti and a maximum of **290 mg/l** in winter near old Durga Mandir, Jaynagar. No significant variation was noticed.

Total Hardness

In present study the observed values range from **265 to 290 mg/l** in winter ,**292 to 306 mg/L** in summer, **268 to 306 mg/l** in rainy season and **278 to 296 mg/l** in spring. Although hard water has no known effect on health but is unsuitable for domestic uses (**Wolf et al, 2013**).Therefore, the water of river Kamla is unsuitable for domestic and other purposes.

Turbidity

The drinking water limit for turbidity as prescribed by World Health Organization is **25 NTU**. The turbidity values in samples varied from **17 to 23 NTU** in winter, **19 to 24 NTU** in summer, **20 to 27 NTU** in rainy season and **18 to 22 NTU** in spring season. The water near old Durga Mandir and Kali Mandir, Jaynagar is most turbid throughout the study period due to low discharge of water. The probability of presence of pathogenic organisms is also increased in turbid water (**Kumar & Chopra, 2012**).

Conductivity

Electrical conductance is reciprocal to electrical resistance and μmho values shows total ion per cm. It is numerical expression of the ability of water sample to carry an electric current (**Kumar & Sinha, 2010**). The value ranged from maximum of **549 $\mu\text{mho/cm}$** in winter near Navtoli and Kuarpatti to minimum of **439 $\mu\text{mho/cm}$** in summer near Navtoli.

Sulphate

In present study the observed values range from **0.635 to 0.900 mg/l** in winter ,**0.680 to 0.880 mg/L** in summer, **0.698 to 0.910 mg/l** in rainy season and **0.545 to 0.746 mg/l** in spring. The value ranged from maximum of **0.910 mg/l** in rainy near NH-57 Jhanjharpur to minimum of **0.545 mg/l** in spring near NH-104 bridge, Jaynagar.

Chloride

Chloride is one of the major inorganic anion in water and waste water (Ensink et al, 2010). The Chloride value shows variation with a range of **46.3 mg/l** in summer near Navtoli to **66.2 mg/l** in winter near NH-57 Jhanjharpur. The chloride values remain higher in winter season.

Phosphate

Phosphate is an important plant nutrient and plays a role of limiting factor among all other plant nutrient so, its determination is useful (Rakib & Bhuiyan, 2014). The value of **Phosphate** varies from minimum of **1.0 mg/l** in spring near NH-104 bridge, Jaynagar to maximum of **1.8 mg/l** in rainy near NH-57 Jhanjharpur .Significantly, lower Phosphate content was recorded near NH-104 bridge, Jaynagar.

Nitrate

Nitrate represents the end product of oxidation of nitrogenous matter and its concentration may depend on the nitrification and denitrification activities of microorganisms. The concentration of microorganisms range with the **Nitrate** value of **0.015 mg/l to 0.985 mg/l** (Lansdown K., 2012). The recorded values of **Nitrate** were significantly higher in summer. The maximum Nitrate value was found **0.786 mg/l** in summer near NH-57 Jhanjharpur to minimum of **0.554 mg/l** in winter near NH-104 bridge, Jaynagar.

Dissolved oxygen (DO)

DO is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc (Premlata V., 2009). Temperature plays an important role in determining **Dissolved Oxygen** in an aquatic body. **Dissolved oxygen** data are valuable in determining the water quality of an aquatic system. In the system where rate of respiration and organic decomposition are high, the **DO** values remain lower than those of system where the rate of photosynthesis is high. A high pollution load may also decrease the **DO** values to considerable level (Komala, et al, 2013). The **DO** values range from a minimum of **4.4 mg/l** in summer near old Durga Mandir, Jaynagar to maximum of **7.3 mg/l** in spring near NH-57 Jhanjharpur. Lower **DO** values during summer may be attributed to the high temperature and its consumption due to high growth and activities of microorganisms.

Biological oxygen demand (BOD)

BOD is used as a measure of the amount of organic matter in an aquatic system which ultimately supports the growth of microorganisms (Onda, et al, 2012).The **BOD** values range from **4.8 mg/l** in spring near NH-57 Jhanjharpur to a maximum of **10.9 mg/l** in summer near Kali Mandir, Jaynagar. Usually higher **BOD** values in summer and lower in the spring season were recorded.

Table-1 : Physico-chemical properties (from Feb 2013 to Jan 2014) of River Kamla in between Jaynagar to Jhanjharpur

S.No.	Stations	Seasons	Parameters						
			Temp. (ac)	pH	Alkalinity (mg/l)	Hardness (mg/l)	Turbidity (NTU)	Conductivity (umho/cm)	TDS mg/l
01	Near NH-104 Bridge Jaynagar	Summer	31.6	7.7	254	298	23	442	1050
		Rainy	26.6	8.1	205	288	25	518	1210
		Winter	20.6	8.2	280	282	21	513	1000
		Spring	26.4	8.0	265	278	21	482	1070
02	Near Kali Mandir Jaynagar	Summer	31.8	7.6	260	297	24	445	1060
		Rainy	26.8	8.3	210	301	27	524	1230
		Winter	21.1	8.4	285	274	22	540	1005
		Spring	26.6	8.2	275	284	22	489	1085
03	Near Old Durga Mandir Jaynagar	Summer	31.8	7.5	250	306	23	446	1025
		Rainy	26.8	8.4	215	306	27	525	1145
		Winter	21.4	8.6	290	265	23	546	995
		Spring	26.9	8.5	280	296	22	485	1060
04	Near Navtoli	Summer	31.7	7.8	245	299	19	439	960
		Rainy	25.7	8.2	210	304	22	525	1055
		Winter	21.2	8.6	275	268	18	549	890
		Spring	26.5	8.2	265	278	18	482	980
05	Near Kuarpatti	Summer	31.2	7.8	255	298	19	453	970
		Rainy	25.4	8.0	200	304	21	519	1050
		Winter	20.6	8.5	280	266	17	549	885
		Spring	25.9	8.1	270	278	18	480	990
06	Near NH-57 Jhanjhar-pur	Summer	30.8	7.7	250	292	19	465	950
		Rainy	25.2	7.9	205	295	20	515	1040
		Winter	20.8	8.5	275	268	18	548	870
		Spring	25.8	8.0	260	279	18	478	980

Table-2 : Physico-chemical properties (from Feb 2013 to Jan 2014) of River Kamla in between Jaynagar to Jhanjharpur

S.No.	Stations	Seasons	Parameters						
			Sulphate (mg/l)	Chloride (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	D.O. (mg/l)	BOD mg/l	COD mg/l
01	Near NH-104 Bridge Jaynagar	Summer	0.680	48.0	1.3	0.718	4.6	10.4	66.3
		Rainy	0.698	53.0	1.5	0.716	5.7	8.4	51.3
		Winter	0.635	60.4	1.1	0.554	6.2	7.2	48.6
		Spring	0.545	59.0	1.0	0.596	5.9	7.8	52.4
02	Near Kali Mandir Jaynagar	Summer	0.696	48.1	1.3	0.722	4.5	10.9	71.8
		Rainy	0.715	48.2	1.5	0.732	5.5	8.9	62.8
		Winter	0.685	65.2	1.2	0.584	6.0	7.9	48.8
		Spring	0.580	58.8	1.2	0.693	5.7	8.2	51.4
03	Near Old Durga Mandir Jaynagar	Summer	0.699	48.3	1.4	0.738	4.4	10.5	63.4
		Rainy	0.765	50.3	1.6	0.734	5.4	8.9	53.4
		Winter	0.725	64.3	1.2	0.592	6.1	7.6	48.6
		Spring	0.625	56.3	1.2	0.698	5.8	7.9	52.4
04	Near Navtoli	Summer	0.799	46.3	1.4	0.764	6.6	7.3	46.2
		Rainy	0.825	52.3	1.7	0.734	6.9	6.9	42.2
		Winter	0.804	65.3	1.4	0.596	6.0	7.6	48.8
		Spring	0.665	59.0	1.3	0.698	7.1	5.4	32.3
05	Near Kuarpatti	Summer	0.869	48.5	1.5	0.784	6.2	7.1	44.0
		Rainy	0.895	47.1	1.7	0.738	7.0	5.6	34.2
		Winter	0.805	65.8	1.4	0.598	6.5	6.8	42.6
		Spring	0.712	59.8	1.3	0.746	7.2	4.9	31.5
06	Near NH-57 Jhanjhar-pur	Summer	0.880	52.9	1.5	0.786	5.9	7.8	45.8
		Rainy	0.910	52.9	1.8	0.734	7.1	5.8	35.3
		Winter	0.900	66.2	1.5	0.612	6.4	6.4	38.7
		Spring	0.746	60.8	1.4	0.713	7.3	4.8	29.4

Chemical oxygen demand (COD)

COD determines the amount of Oxygen required for chemical oxidation of organic matter using a strong chemical oxidant such as Potassium dichromate under reflux conditions(Rai, et al, 2012). The minimum COD values of 29.4 mg/l were found in spring near NH-57 Jhanjharpur and maximum of 71.8 mg/l in summer near Mahavir Mandir, Jaynagar .The COD values were higher near Kali Mandir, Jaynagar whereas, no significant variation was observed between other stations.

Total dissolved Solids (TDS)

Total dissolved Solids (TDS) analysis has great implications in the control of biological and physical waste water treatment processes. The largest amount of total solids adds to the high turbidity and electrical conductivity (Kumar & Chopra, 2012). The Total dissolved Solids (TDS) determined in these studies ranged between 870 to 1070 mg/l in winter, 950 to 1060 mg/l in summer , 1040 to 1230 mg/l in rainy season and 980 to 1085 mg/l in spring season.

IV. CONCLUSION

Analysis of the water samples collected in Kamla river revealed that, in general various parameters are not within the range of standard values prescribed by various agencies. The water is polluted at all the stations during the course of study and it is unfit for consumption, domestic and irrigation purposes. It can be concluded that near Kali Mandir and old Durga Mandir, Jaynagar, river water is more polluted whereas, all the other four stations are found less polluted.

ACKNOWLEDGMENT

The first author is thankful to The Head, Department of Botany for providing necessary laboratory facilities.

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