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Original Research Paper

Effect of the Khan River Water on Chlorophyll Content, Carotenoids and Enzyme Activities of *Ipomoea fistulosa* and *Polygonum barbatum*

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ABSTRACT

In present study, the physico-chemical characteristics of the Khan river at four selected polluted stations were measured. Two plant species, *Ipomoea fistulosa* and *Polygonum barbatum*, which grow abundantly at all sampling stations of the Khan river bank, were selected to determine the effect of pollutants on chlorophyll contents (chl-*a*, chl-*b*, total chlorophyll), carotenoids, nitrate reductase and peroxidase activity. The study revealed that all the selected physico-chemical parameters were higher at Kabirkheri (Station 4) which indicated that pollution load was much higher at this station as compared to the other three stations. Chl-*a*, chl-*b*, carotenoids, total chlorophyll, nitrate reductase and peroxidase activity all parameters were higher at Station 4. Among both the selected plant species *Polygonum barbatum* showed good correlation with pollutants for all parameters studied.

INTRODUCTION

Indore is a commercial city of Madhya Pradesh where industrialization and urbanization have increased gradually. The domestic sewage and industrial wastes are carried by below ground and surface drains, which are finally dumped into the Khan River (Rao et al. 1978, Ganasan & Hughes 1998, Sharma & Dubey 2011). Sewer lines also receive large amount of municipal wastewater and converted into the small nallahs (Sharma & Dubey 2011). Pollutants affect not only river water but plants also which are growing along the river bank. Earlier work has indicated that industrial effluents affect chlorophyll content of plants (Raja & Vijaya Kumar 1989a, b, Sahai et al. 1983, Srivastava & Sahai 1987). Many plant species are growing along the bank of Khan river, which can act as good bioindicator and bioaccumulator for the pollutants. Out of these, two plant species *Ipomoea fistulosa* and *Polygonum barbatum* were studied, which grow abundantly along the river bank. The present work aims at studying the water quality parameters of Khan river and its effects on chlorophyll content, carotenoids, nitrate reductase and peroxidase activity of *Ipomoea fistulosa* and *Polygonum barbatum*.

MATERIALS AND METHODS

Study area: The Khan river is a tributary of River Kshipra. It flows a length of about 64 km through the Indore city. About 110 MLD sewage and 70 MLD industrial wastes are added to it per day, which not only affect its quality but also plants growing around its bank. In present work four sampling stations, viz. GPO, Nasia Road, Bhagirathpura and Kabirkheri were selected from origin of the river towards downstream (Fig. 1). GPO is the first sampling station which receives wastewater from surrounding colonies, temples, zoo and agricultural run off, industrial waste from palda village, situated near this site. Nasia Road is the second sampling station, which receives wastewater from hotels, hospitals, colleges and houses. Bhagirathpura, the third sampling station receives industrial effluents from many industries situated around it along with domestic sewage of households and Pallasia nalla. Kabirkheri is the fourth sampling station. It receives pollutants from the city, agricultural fields and some industries. Two plant species *Polygonum barbatum* and *Ipomoea fistulosa* are found at all the four sampling stations. *Polygonum barbatum* (Polygonaceae) is a perennial herb, which grows widely in marshy and aquatic places, by the side of the river. *Ipomoea fistulosa* (Convolvulaceae) is a perennial shrub, which grows along the river bank and roadside ditches, particularly near rural habitation.

Sampling and analysis: Water samples were collected in clean plastic containers from selected stations once in a month in the year 2009. Immediately after collection the samples were brought to the laboratory for analysis of physico-chemical parameters. Temperature, pH, conductivity, total solids, total suspended solids, total dissolved solids, total hardness, calcium hardness, magnesium hardness, chlorides, ammonical-N, nitrate-N, nitrite-N, DO, BOD, phosphate and sulphate were analysed by standard methods described in APHA, AWWA, FSIWA (2005). Plant leaf samples were

collected from the above mentioned sampling stations, which are growing in natural conditions in river bank area. For analysis of chlorophyll contents, leaves were collected in the morning period (8 to 9 a.m.) from the selected sampling stations in polythene bags, kept in ice box and brought to the laboratory. Chlorophyll contents and carotenoids were estimated according to Arnon's (1949) and Duxbury & Yentsch (1956) method. Nitrate reductase and peroxidase enzymes were analysed according to Shrivastav & Mathur (1980) and Chance & Maehly (1955) respectively. Average values of the physico-chemical properties of the Khan river water with standard deviation (SD) were taken. Data were statistically analysed for both positive and negative correlations.

RESULTS AND DISCUSSION

Physico-chemical characteristics of water: The results of physico-chemical analysis of Khan river water at the four sampling stations are given in Table 1. Results revealed that all the selected water quality parameters of polluted stations were higher at Station 4 except dissolved oxygen. This shows that Station 4 was highly polluted due to both domestic and industrial wastes. DO was zero at Stations 3 & 4 and very low at Stations 1 & 2. High value of BOD determines that concentration of organic matter is higher which increases microbial activity and decreases DO. Slight variation in temperature was recorded from Station 1 to Station 4. pH at all the stations was alkaline in nature. Temperature and pH

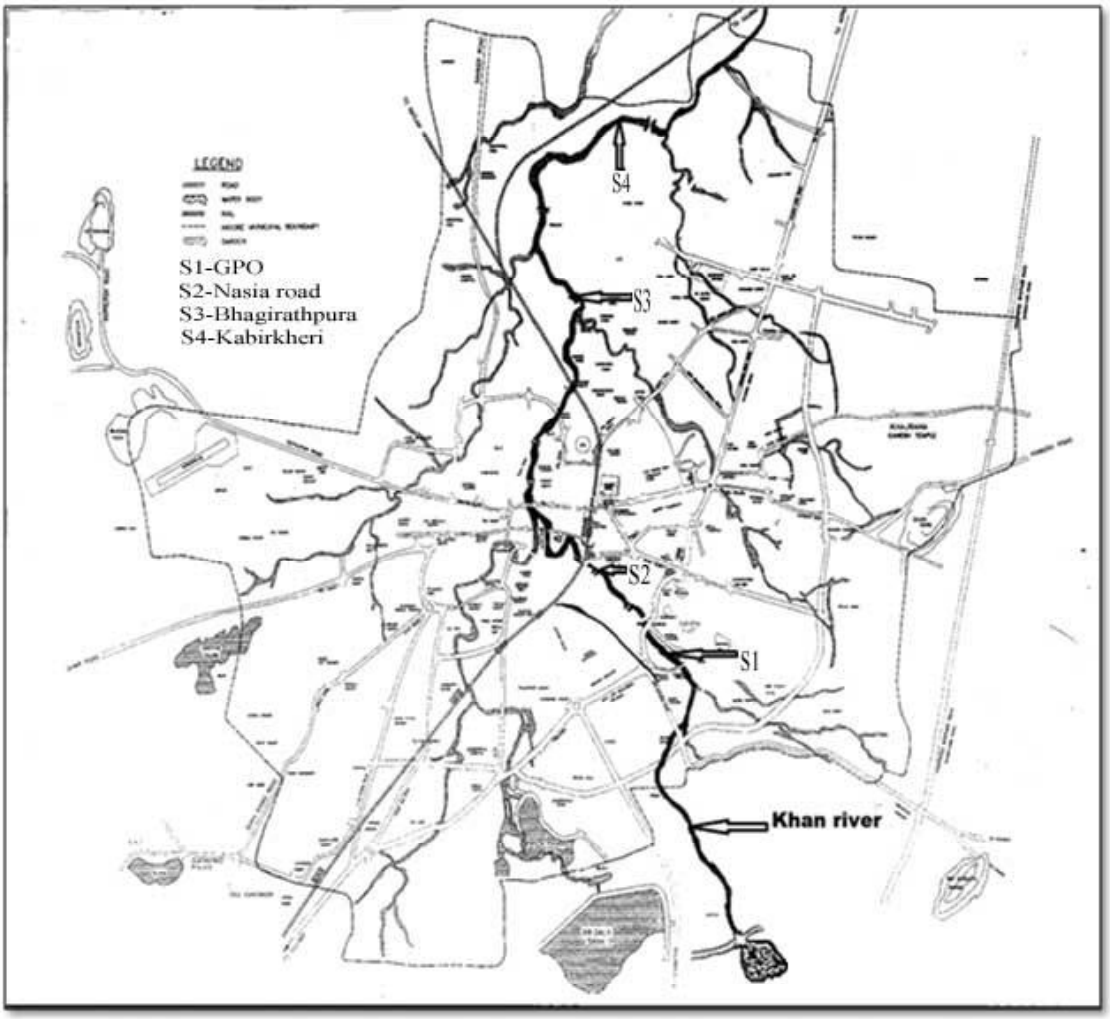

Fig. 1: Map showing the location of four selected sampling stations along the Khan river, Indore.

Table 1: Average values of physico-chemical parameter of the Khan river water at four polluted sites in the year 2009.

Site Parameters	S1 (GPO) ±Avg SD	S2 (Nasia road) ±Avg SD	S3 (Bhagirathpura) ±Avg SD	S4(Kabirkheri) ±Avg SD
Temperature	25.57±3.33	26.43±3.51	27.02±3.72	28.51±4.25
pH	7.85±0.14	7.88±0.15	7.96±0.21	8.20±0.29
Conductivity	1589.83±245.09	1727.42±229.57	1712.83±240.30	1912.08±205.73
Total Solids	1327.17±89.20	1439.08±92.71	1479.25±93.00	1741.50±204.15
Total Suspended Solids	156.08±15.34	166.25±13.62	183.42±15.39	214.75±39.76
Total Dissolved Solids	1171.08±79.29	1272.83±83.72	1312.50±73.30	1526.75±172.91
Total Hardness	379.42±20.51	403.75±24.05	393.17±40.43	422.42±40.97
Ca Hardness	253.25±30.46	283.50±25.02	271.92±21.93	326.67±42.03
Mg Hardness	126.17±20.31	120.25±16.26	121.25±24.52	95.75±20.40
Chloride	182.92±53.66	201.17±49.23	212.92±52.19	238.58±56.99
Ammonical-N	3.294±2.05	5.916±3.16	6.238±3.34	7.669±3.03
Nitrate-N	8.490±3.68	10.156±4.43	10.999±4.64	12.548±3.84
Nitrite-N	0.247±0.16	0.275±0.17	0.286±0.18	0.381±0.27
DO	0.18±0.30	0.09±0.14	Nil	Nil
BOD	60.83±31.98	76.58±35.78	84.83±37.51	106.92±36.43
Phosphate	0.400±0.32	0.675±0.42	0.761±0.46	1.199±0.50
Sulphate	27.08±9.55	34.50±11.36	37.97±13.43	48.75±19.77

All the values are expressed in mg/L except pH, water temperature (in °C), conductivity (µS/cm).

Table 2: Comparitive values of correlation of *Ipomoea fistulosa*, *Polygonum barbatum* with water quality parameters of the Khan river during 2009.

Parameters	Total Chlorophyll		Carotenoids		Nitrate Reductase Activity	
	Ipomoea	*Polygonum*	*Ipomoea*	*Polygonum*	*Ipomoea*	*Polygonum*
Temperature	0.93	0.92	0.80	0.95	0.17	0.98
pH	0.94	0.93	0.81	1.00	0.11	0.91
Conductivity	0.82	0.98	0.63	0.92	-0.06	0.92
Total Solids	0.90	0.96	0.75	0.97	0.05	0.94
Total Suspended Solids	0.96	0.90	0.85	0.97	0.23	0.96
Total Dissolved Solids	0.91	0.96	0.75	0.97	0.07	0.95
Total Hardness	0.69	0.98	0.46	0.84	-0.24	0.84
Ca Hardness	0.77	1.00	0.56	0.92	-0.18	0.86
Mg Hardness	-0.84	-0.98	-0.66	-0.98	0.10	-0.84
Chloride	0.93	0.91	0.79	0.93	0.19	0.99
Ammonical-N	0.79	0.85	0.63	0.78	0.12	0.96
Nitrate-N	0.90	0.88	0.77	0.88	0.86	0.99
Nitrite-N	0.90	0.97	0.74	0.99	0.02	0.91
DO	-0.83	-0.64	-0.78	-0.68	-0.48	-0.95
BOD	0.92	0.92	0.78	0.93	0.16	0.98
Phosphate	0.90	0.95	0.74	0.94	0.09	0.96
Sulphate	0.91	0.93	0.77	0.93	0.14	0.98

increases at Stations 3 & 4 due to addition of some industrial effluents. Higher values of total solids and total dissolved solids at Station 4 must be due to higher concentration of carbonates, bicarbonates, phosphates, sulphates, salts and ions. Total hardness at Station 3 was lower than Stations 2 and 4. High conductivity indicates presence of salts and ions in higher concentration. Phosphates and sulphates were higher at Station 4 because of agricultural run off, detergents, domestic sewage, etc. Chloride was also found in increasing order from Station 1 to Station 4. It might be due to high concentration of pollutants such as bleaching agents, paints, organochlorine, pesticides, and acids of electroplating industries. Increase in chloride content due to pollution has also been reported by Mohapatra & Purohit (2002). Higher values of ammonical nitrogen, nitrates and nitrites indicate presence of excessive organic matter containing nitrogenous compounds due to agricultural run off and organic wastes.

Biochemical parameters of the plant species: The results of the biochemical parameters of the plants at the four sampling stations are given in Fig. 2. In both the selected plant species, value of chlorophyll-*a*, carotenoids and total chlorophyll were higher at Station 4. In *Ipomoea fistulosa* chl-*b* was lower at Station 4 as compared to *Polygonum barbatum.* Nitrate reductase activity was found in increasing

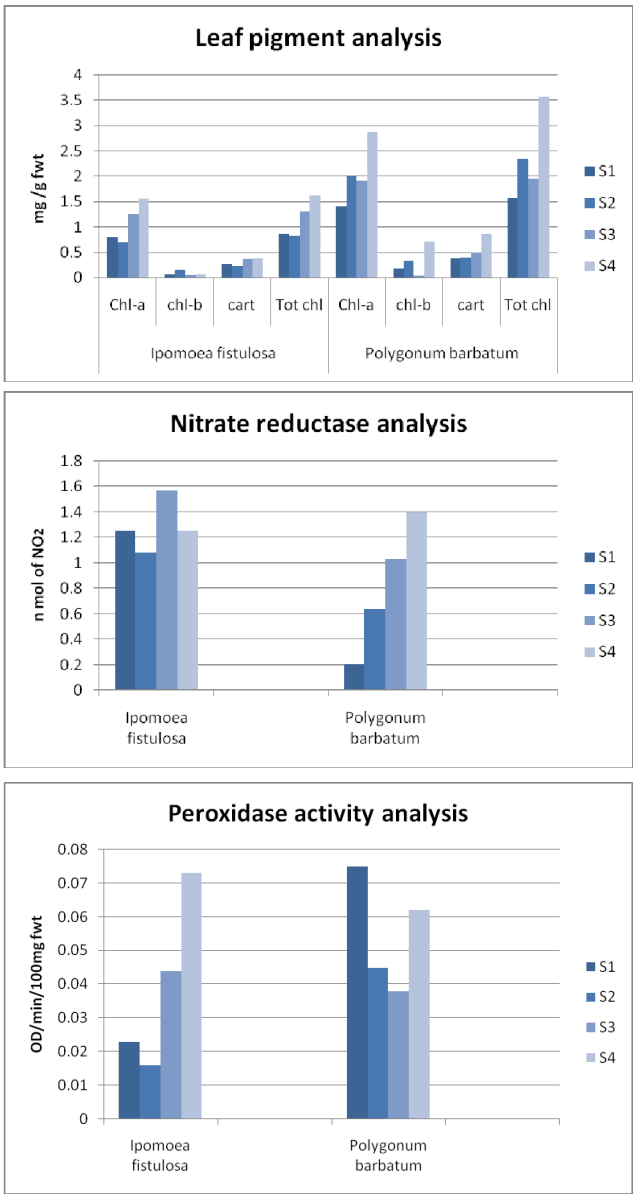

Fig. 2: Biochemical analysis of *Ipomoea fistulosa* and *Polygonum barbatum*.

order from Station 1 to Station 4 in *Polygonum barbatum* but in *Ipomoea fistulosa* it was higher at Station 3. This may be due the habitat differences. *Polygonum barbatum* grows in marshy areas of the Khan river and takes nutrients mostly from wastewater but *Ipomoea fistulosa* grows slightly away from the Khan river bank and takes nutrients mostly from soil. It seems that availability of nitrogen compounds is more to *Ipomoea fistulosa* as compared to *Polygonum barbatum*. Nitrogen plays an important role and stimulates vegetative growth (Khan et al. 2003, Saravanmoorthy & Ranjitha Kumari 2007). Carotenoids are photosynthetic pigments and function as nonenzymatic antioxidant protecting plants from oxidative stress (Gruszecki & Strzal-ka 1991). In both the selected plant species carotenoid content showed higher value at Stations 3 & 4. This may be due to presence of some heavy metals. An increase in carotenoid content is suggested as a defence strategy of the plants to combat metal stress (Sinha et al. 2007). Peroxidase plays a significant role in defence against oxidative stress and is suggested to be indicator of metal toxicity (Radotic et al. 2000). Higher peroxidase activity in both the selected plant species at Station 4 might be due to presence of heavy metals.

Correlation between physico-chemical parameters of water and biochemical parameters of the plants: The results of correlation between physico-chemical parameters of water and biochemical parameters of the plants are given in Table 2. Results show existence of both positive and negative correlations. Total chlorophyll contents of both the plant species show strong correlation with temperature, pH, total suspended solids, total dissolved solids, chloride, nitrite nitrogen, BOD, phosphates and sulphates. Conductivity, ammonical nitrogen and total hardness are more positively correlated with total chlorophyll of *Polygonum barbatum* than to *Ipomoea fistulosa*. Nitrate nitrogen is more strongly correlated to total chlorophyll of *Ipomoea fistulosa* as compared to *Polygonum barbatum*. Carotenoids of *Polygonum barbatum* are also closely correlated with temperature, pH, conductivity, total suspended solids, total dissolved solids, chlorides, nitrite nitrogen, BOD, phosphates and sulphates as compared to *Ipomoea fistulosa*. Nitrate reductase activity of *Polygonum barbatum* is also increasing with rise in temperature, pH, conductivity, total suspended solids, total dissolved solids, chlorides, ammonical nitrogen, nitrate nitrogen, nitrite nitrogen, BOD, phosphates and sulphates. However, DO shows negative correlation with total chlorophyll, carotenoids and nitrate reductase activity in both the plant species.

CONCLUSION

The increase in all biochemical parameters in the two species from Station 1 to Station 4 clearly indicates increasing amount of pollutants in the Khan river as it passes through Indore city. Strong correlation of various physico-chemical characteristics of water with carotenoids might be due to increasing oxidative stress. It is indicative of presence of high amount of heavy metals and damaging pollutants. Earlier studies have shown that *Polygonum barbatum* is a bioaccumulator of heavy metals. This is evident from present study also as *Polygonum barbatum* shows higher values of carotenoids and peroxidase activity over that of *Ipomoea fistulosa*. The results show that polluted water of the Khan river must be treated before using it for irrigation purpose.

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