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IMPACT OF INDUSTRIAL EFFLUENT ON QUALITY OF WATER AND PHYTOPLANKTON DIVERSITY OF RIVER TONS AT AKBARPUR (U.P.) INDIA

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ABSTRACT

The present study investigated the water quality of Tons River (Akbarpur, U.P.) phytoplankton abundance, diversity and the effect of pollutants on phytoplankton as well as the primary productivity. The water of the collected sample was mostly alkaline (7.01–8.2) and showed a wide range of variation in EC (1171–2700 µS/cm), TDS (576–1345 mg/L), DO (0.92–2.7 mg/L), free CO_2 (15–31 mg/L), BOD (12.03–28.38 mg/L) and COD (101.2–109.2 mg/L). A total of 44 species were identified of which 7 belonged to Chlorophyceae, 11 Cyanophyceae, 14 Euglenophyceae and 12 Bacillariophyceae. Among all the members, Bacillariophyceae were found to be dominant and lowest of Chlorophyceae indicates that this group is more sensitive to the pollutants discharged by industry.

KEYWORDS: Water Quality; Industrial Effluent; Phytoplankton; Biodiversity; Aquatic Ecosystem

River have been a very important source of life from the start of civilization and indeed some of the oldest civilization of the world developed along the river bank viz. those of Indus and Nile. Despite a close linkage of humanity with rivers, it has been man's own diversified activities which contaminated/polluted the rivers. Today most of the rivers of the World receive millions of litter of sewage, domestic wastages, industrial and agricultural effluents with the growth of Industries and population along the blank of rivers, the quantum as well as variety of wastes have increased several times which eventually play have with the aquatic life and human health.

Rivers have been considered as sacred since ancient times of India. There are fourteen major rivers in India. Brahmani, Brahmaputra, Cauvery, Ganga, Godawari, Indus, Krishna, Mahanadi, Mahi, Narmada, Perrair, Sabarmati, Subarnarkha, Tapti & Gomati which share 83% of the total drainage basin, contributes 85% of the total surface flow and also house 80% of the total population of the country. Though much work has been done on pollutions of river passing dignified cities but small contributory rivers covering rural areas or less dignified cities have been plain less attention or have totally been ignored. One of them is Tons river. Although Tons river is smaller in comparison to Gomati river but it is also a very polluted river. The ever expanding socio-economic, cultural & technological spans rapid growth of population and industrialization in the country, it has become vital to check the pollution in small river like Sai, Varuna, Peeli, Bakulahi and in other small rivers and its removal, because these small rivers are connected to big rivers and increase the pollution in them.

Water is the most valuable and vital resource for sustenance of life. Freshwater makes up only less than 3% of earth's water and is the source of virtually all drinking waters. Some 55% of that water comes from reservoirs, rivers, streams and lakes; and these sources are vulnerable to pollution. Rapid urbanization and industrialization of Bangladesh have negative implications for water quality, where the industrial effluents directly discharge into the rivers without any consideration of the environment (BCAS, 2000). Phytoplankton constitutes the foundation of the food web in aquatic ecosystems and represents one of the most direct and profound responses to pollution entering water bodies (Onyema, 2010). They are simple, capable of quantifying changes in water quality, applicable over large geographic areas and can also furnish data on background conditions and natural variability (Abowei and Sikoki, 2005). In the country, most of the industries like textiles, pharmaceuticals, tanneries, paper mills and oil refineries are situated on the bank of rivers and discharge their effluents directly into it. Besides, huge quantities of solid waste from river-side settlements, varieties of chemical fertilizers and residues of pesticides, petroleum products from ships, launches cargoes, boats, untreated sewage etc. regularly get dumped into these rivers (Khan *et al.*, 2007). These pollutants inhibit the growth of aquatic flora and fauna. Thus aquatic diversity is now in threatened condition.

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A wide variety of flora and fauna exists in the Yamuna basin, and their spatial variability largely depends on the geophysical environment (Rai *et al.*, 2012). The drainage basin of the river, particularly till it meets the plateaus, is filled with semi alpine, alpine sub-tropical and temperate foliage, and huge stretches are covered by jungles aids in survival of a variety of wildlife. All planktonic and benthic communities determine processes, functions and attributes related to the aquatic ecosystem (Tare, 2012). The water quality characteristics strongly influence distribution and extent of biodiversity in river and subtle morphological and physiological change (Malhotra *et al.*, 2014). Many researchers have put their sincere efforts for biodiversity studies along rivers.

Development process, industrialization anthropogenic activities and population explosion have affected environmental quality in many ways, with attendant negative impacts on the environment and human health. Various devastating ecological and human disasters of the last four decades implicate industries as a major contribution to environmental degradation and pollution (Abdel-Shafy and Abdel-Basir, 1991) (Ademoroti and Sridhar, 1979) (Asia and Ademoroti, 2001). By mixing of Industrial Effluents and domestic wastes into water bodies not only affects the water quality of fresh water bodies but also has the deleterious impact on the aquatic ecosystems and soil micro flora (Abida *et al.*, 2009) (Baskaran *et al.*, 2009) (Islam and Azam, 2015) (Islam *et al.*, 2010) (Kaur *et al.*, 2010) (Sirohi *et al.*, 2012). It has been realized that discharges of untreated or incompletely treated wasters containing algal nutrients, non-biodegradable organics, heavy metals and other toxicants will hasten the deterioration of receiving water bodies. There has been growing awareness of the need for effective treatment of various effluents before discharging into any public water body.

India ranks amongst the first ten of heavily industrialized countries of the World. River pollution in necessary evil of essentially all the development activities. Thus has resulted in a heavy back log of gaseous, liquid and solid pollution in the rivers of the country.

Gomati river shows great diversity in flora & fauna. The flora of Gomati includes several micro organisms, phytoplanktons and macrophytes. There are about 64 types of algae reported in Gomati water belonging to different groups like Chlorphyceae, Cyanophyceae, Bacillariophyceae & Euglenophyceae etc.

The present study was therefore undertaken to investigate the water quality of Tons River, its effects on phytoplankton habitat and assess the diversity and abundance of phytoplankton species.

MATERIALS AND METHODS

Water samples were collected from 10 locations of the Tons River, at Akbarpur District (U.P.) receiving effluents from different industries January-May, 2018. During sampling, sample bottles were rinsed with river water to be sampled three times. Water samples were collected from the depth of about 15-25 cm from surface and tried to avoid bubble formation and addition of suspended particles as possible. All the samples were properly labeled and carried out using disposable hand gloves with proper care and stored in ice box. The pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS) of river water were measured on spot by using calibrated digital multimeter and temperature using mercury centigrade thermometer. Electric conductance (EC) was measured at 25^0C in μS/cm, using an electric conductivity meter. Biological Oxygen Demand (BOD) was done by 5-days incubation, 20^0C method and COD measured by closed reflux colorimetric method using Colorimeter. Free CO_2 was also measured by following (APHA, 2005) standard method. For biological analyses, collection, preservation and qualitative assessment of phytoplankton were done by (Johansen, 1940) using an electronic microscope and the classification proposed by (Bold and Wynne, 1985) was followed.

RESULTS AND DISCUSSION

Water Quality

Physicochemical parameters of the 10 sampling points are presented in Table 1. River water comprises temperature from 27–31^0C with an average 28.6^0C, and the range of pH from 7.01–8.2 with an average 7.51 (Table 1). Generally aquatic organisms are affected by pH, because most of their metabolic activities are dependent on it. It is an important indicator of water quality and the extent of pollution in aquatic ecosystem (Kumar *et al.*, 2011). Optimal range of pH for sustainable aquatic life is 6.5–8.0 and result showed that, pH values were within the permissible limit except the sample S-7. Fluctuations in pH values within different sampling points attributes the factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction of temperature, and decomposition of organic matter (Rajasegar, 2003).

Electric conductivity (EC) showed a wide variation from 1171 μS/cm to 2700 μS/cm with an average 1671.10 μS/cm. Although it is not a human or aquatic health concern; but it can serve as an indicator of other water quality parameters. The acceptable range of

EC for recreational water is 500 μS/cm, irrigation is 750 μS/cm and aquaculture is 800-1000 μS/cm (ADB, 1994). From the study it showed that, measured EC of the Tons River was below the acceptable range. In water, total dissolved solids (TDS) are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda *et al.*, 2010). The high TDS value of the water is the result of different sewage, domestic waste, industrial and agricultural effluents. In the collected samples, TDS varied from 576-1375 mg/L with an average 857.5 mg/L (Table 1). The acceptable standard of TDS for drinking water is 1000 mg/L industrial water is 1500 mg/L and irrigation is 2000 mg/L (ADB, 1994). The values of all measured samples except, S-1, S-2, S-6 and S-7 were fall within permissible limit of drinking, industrial and agricultural uses.

Dissolved oxygen (DO) is most vital parameters in water quality assessment and reflects the physical and biological processes prevailing in the water (Trivedi and Goel, 1984). Where the rates of respiration and organic decomposition are high, the DO values usually remain lower, than where the rate of photosynthesis is high (Mishra *et al.*, 2009). When the water is polluted with large amount of organic matter, a lot of dissolved oxygen would rapidly consumed in the biological aerobic decay which would affect the water quality and aquatic lives (Chhatwal, 2011). The DO concentration of Shitalakhya River varied from 0.92–2.7 mg/L with an average 1.57 mg/L. In case of dissolved oxygen, standard for sustaining aquatic life is 5.0 mg/L, whereas drinking water purpose is 6.0 mg/L (Alam *et al.*, 2007). The acceptable range of DO for domestic water supplies is 4.0–6.0 mg/L by United State Public Health (USPH) standard (De, 2005). The standard range of DO for fish culture is 5.0 mg/L to saturation (Meade, 1998) and more than 5.0 mg/L (Chowdhury and Chowdhury, 2004). According to the environmental quality standard (EQS, 1997), DO level should be 6.0 mg/L for drinking 4.0-5.0 mg/L for recreation 4.0–6.0 mg/L for fish and livestock and 5.0 mg/L for industrial application. On the basis of the study, the measured values of DO of Tons River water were not within the acceptable range and not suitable for aquatic lives.

Table 1: **Physicochemical parameters of the water samples of Tons River**

Parameters	Sampling points										
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	Avg.
Water temp in ^{0}C	27	28	27	31	28	28	29	28	29	31	28.6
pH	7.43	7.47	7.63	7.38	7.41	8.0	8.2	7.25	7.37	7.01	7.51
EC (μS/cm)	2130	2700	1224	1295	1601	2170	1807	1312	1301	1171	1671.10
TDS (mg/L)	1067	1375	606	639	797	1147	1097	647	642	576	857.5
DO (mg/L)	0.92	1.22	2.7	1.35	1.38	2.2	1.2	1.03	1.2	2.5	1.57
Free CO_2 (mg/L)	19	17	25	13	31	15	16	19	19	17	19.10
BOD (mg/L)	22.12	15.24	12.62	17.98	16.18	15.54	28.38	12.03	14.98	16.54	17.16
COD (mg/L)	105.3	105.6	107.2	104.1	104.9	108.9	109.2	102.6	102.2	101.2	105.12

Free CO_2 is essential components for photosynthetic plants or organisms and in the study area it was reported from 13-25 mg/L (average 19.10 mg/L), are not suitable for living organisms. Biochemical oxygen demand is a measure of the oxygen in the water that is required by the aerobic organisms. High BOD levels indicate lower in DO, because the oxygen that is available in the water is being consumed by the bacteria leading to the inability of fish and other aquatic organisms to survive in the river (Pathak and Limaye, 2011). The value of BOD of the collected samples were 12.03-22.12 mg/L with average 17.16 mg/L. The permissible limit for BOD for drinking water is 0.2 mg/L, for recreation 3.0 mg/L, for fish culture 6.0 mg/L and 10.0 mg/L for irrigation. COD is commonly used to measure the amount of organic compounds present in water, which makes COD as an indicator of organic pollution of surface water (Kumar *et al.*, 2011). The value of the COD varied from 101.2-109.2 mg/L and average 105.12 mg/L. All the observed values indicate that, water quality is deteriorated by nearby industrial effluent discharge. Some workers also found very similar observation in case of water quality deterioration of Kali River (Sirohi *et al.*, 2014).

Phytoplankton Diversity and Abundance

Total 44 species were identified, from the collected water samples from study area. Among them members of Bacillariophyceae were found to be dominant. Total 12 species were found in class of Bacillariophyceae, where Naviculaceae and Bacillariophyceae were abundant than others, 14 species of Euglenophyceae, 11 Cyanophyceae and 7

Chlorophyceae species were also found. More or less similar observations were made by (Begum and Khanam, 2009) in case of pharmaceuticals effluent. The Taxa recorded in the present study along with their dimension and abundance in different sampling points is given in Table 2 in which the abundance of the two species family is; Euglenaceae and Naviculaceae were evident. These species seem to be resistant to polluted environment. Workers also observed more or less similar abundance of these species by receiving effluents from the textile and pharmaceuticals industries (Begum and Khanam, 2009).

Table 2: List of the observed phytoplankton in water samples of Tons River

Species Class	Species Family	No. of identified species	Abundance	Sampling point wise identified species									
				S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Cynophyceae	Chroococcaceae	4	++	√		√					√	√	√
	Oscillatoriaceae	4	+++	√	√		√	√			√	√	√
	Nostocaceae	3	+++		√	√		√	√	√	√		√
Chlorophyceae	Chlamydomonadaceae	1	+			√							√
	Volvocaceae	2	++	√	√						√	√	
	Scenedesmaceae	2	++		√		√	√			√		
	Chlorellaceae	2	++	√	√						√	√	√
Euglenophyceae	Euglenaceae	13	++		√						√	√	√
	Coscinodiscaceae	1	++			√						√	√
Bacillariophyceae	Naviculaceae	9	+++	√	√				√	√	√	√	√
	Bacillariaceae	3	++		√			√			√	√	√

Here, + = few; ++ = common and +++ = very common

Pollution Effect on Phytoplankton

Generally, phytoplankton or algae are sensitive to pollutants. Growth and photosynthesis are closely related, each being a function of the utilization of light and nutrients. Worker (Dugdale, 1975) described the growth of an algal population as being proportional to the effect of light on photosynthesis, the concentration of nutrients, and the maximum specific growth rate. Industrial pollutants block the light for photosynthetic mechanism and inhibit growth. Pollutants can, therefore, affect photosynthesis and other aspects of energy utilization and incorporation and, thus cause changes in population growth rates. Pollutants may also affect the species composition of the phytoplankton community.

With a few exceptions, among all the groups of phytoplankton recorded, Cyanophyceae and Euglenophyceae showed dominance in all the collected samples (Table 2).

On the contrary lowest representation by the members of Chlorophyceae indicates that this group is more sensitive of the pollutants discharged by the industry. The members of Euglenophyceae appear to be best adapted in the polluted habitat as indicated by 14 species out of 44. The present investigation revealed that the effluents discharged from industries are very harmful for the phytoplankton as well as aquatic ecosystem, and the species is reduced as 78 species were found previously by (Begum and Khanam, 2009).

Recommendations

1. Don't release things which are made up of plaster or any other non biodegradable waste.
2. Implicating a restriction of the use of toxic chemicals in product formulation.
3. Adopting protective measures to prevent leaching of contaminants from sites.
4. Redirecting industrial wastes into containers and then dispose of those containers in special waste treatment plants.
5. For cleaning up the pollution, the rational mind of people and emotional, cultural and religious beliefs is essential.
6. There is a sincere need to punish the polluters and defaulters through a system of fines with adequate bonus to the fine collectors to keep them duty bound and honest.
7. In order to support ecologically and socially sustainable development, necessary to formulate effective plants and policies for industries and development, necessary to formulate effective plants and policies for industries and develop guideline values and regulations to monitor concentrations of heavy metals in surface water of all rivers.
8. Individually, there is a need to be aware of the pollution and reconsider the basic and real value of

the river and spontaneously participate to the plans for cleaning up the river. Small steps can make a big change, so action must be taken from individual level for themselves as well as environmental protection.

CONCLUSION

From the present study, it has been found that, pollutant water is very harmful for phytoplankton diversity as well as the aquatic ecosystem. Euglenophyceae were found to be dominant in study area as appear to be best adapted in the polluted habitat and Chlorophyceae were more sensitive to the pollutants. The abundance of phytoplankton was found comparatively less polluted area and lowest near the pollution source. The ecosystem of Tons River is now fallen in threatened condition due to productivity imbalance by effluent discharge.

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REFERENCES

Abdel-Shafy H.I. and Abdel-Basir S.E., 1991. Chemical treatment of industrial wastewater. Environmental Management and Health, **2**:19-23.

Abida B., Ramaiah M., Harikrishna, Khan I. and Veena K., 2009. Heavy Metal pollution and chemical profile of Cauvery river water. E. Journal of Chemistry, **67**(1): 47-52.

Abowei J.F.N. and Sikoki F.D., 2005. Water pollution management and control (Doubletrust Publication Company, Nigeria), pp. 236.

ADB (Asian Development Bank), 1994. Training Manual for Environmental Monitoring (Eng. Sci. Incorporation, USA), pp. 2-26.

Ademoroti C.M.A. and Sridhar M.K.C., 1979. Fluidized bed technique in Physico-chemical treatment of wastewater. Journal of Effluent and Water Treatment, **19**: 91-97.

Alam M.J.B., Muyen Z., Islam M.R., Islam S. and Mamun M., 2007. Water quality Parameters along rivers, Int. J. Environ. Sci. Techn., **4**: 159-167.

APHA (American Public Health Association), 2005. Standard Methods for Examination of Water and Wastewater, 21st edition (Washington DC), pp. 15

Asia I.O. and Ademoroti M.A., 2001. Performance of some coagulants/ Flocculants in Physico-chemical treatment of aluminum extrusion sludge. Proceedings of the chemical society, Nigeria, 47.

Baskaran L., Sankar G.K., Chidambaram A.L.A. and Sundaramoorthy P., 2009. Amelioration of Sugar Mill Effluent Polluted Soil and its Effect on Green gram (*Vigna radiata* L.). Botany Research International, **2**(2): 131-135.

BCAS (Bangladesh Centre for Advance Studies), 2000. Pollution Study Management of Aquatic Ecosystem through Community Husbandry (MACH) (Dhaka, Bangladesh).

Begum Z.N.T. and Khanam D., 2009. Physicochemical aspects and phytoplankton of the river Shitalakhya receiving pharmacy effluents. Bang. J. Bot., **38**(1): 77-85.

Bold H.C. and Wynne M.J., 1985. Introduction to the Algae (Prentice-Hall, New Jersey); pp. 1-706.

Chhatwal R.J., 2011. Environmental Sciences: A Systematic Approach. 2nd edition (UDH publishers and Distributors (P)Ltd., pp. 104-105.

Chowdhury A.G. and Chowdhury A., 2004. An Assessment of Water Resources and Flood management of Dhaka City, Water Resources Management and Development in Dhaka City, Geothe-institute (Dhake, Bangladesh) pp. 40-45.

De A.K., 2005. Environmental Chemistry 5th Edition (New Age International (P) Ltd., Daryaganj, New Delhi, India), pp. 187.

Dugdale R.C., 1975. Biological modeling I. In modeling of Marine Systems, 1st edition (Elsevier, New York) pp. 187-205.

EQS Environmental Quality Standard), 1997, Government of the People's Republic of Bangladesh, Ministry of Environment and Forest, Department of Environment, (Gazette, registered No. DA-1, Dhaka, Bangladesh).

Islam S.M.D. and Azam G., 2015. Seasonal variation of Physico- chemical and texi properties in three major rivers; Shitalakhya, Buriganga and Turag around Dhaka city, J. Bio. Environ. Sci., **7**(3): 120-131.

Islam M.H., Raman M.M. and Ashraf F.U., 2010. Assessment of water quality and impact of effluents from fertilizer factories to the Lakhya River. International Journal of Water Resources and Environmental Engineering, **2**(8): 208-221.

Johansen D., 1940. Plant Micro Technique (McGraw Hill Book Company Inc. N.Y.), pp. 523.

Kaur A., Vats S., Rekhi S., Bhardwaj A., Goel J., Tanwar R.S. and Gaur K.K., 2010. Physico-chemical analysis of the Industrial effluents and their impact on the soil micro-flora. Procedia Environmental Sciences, **2**: 595-599.

Khan M.A.I., Hossain A.M., Huda M.E., Islam M.S. and Elahi S.F., 2007. Physico-chemical and biological aspects of monsoon water of Aslulia for Economical and Aesthetic Applications: Preliminary studies, Bang. J. Sci. Ind. Res., **42**(4) 377-396.

Kumar V., Arya S., Dhaka A. and Minakshi C., 2011. A study on Physico chemical characteristics of Yamuna river around Hamirpur (U.P.) Bundelkhand region, Central India, Int. Multidisc. Res. J., **38**(1): 77-85.

Mahananda M.R., Mohanty B.P. and Behera N.R., 2010. Physico chemical analysis of surface and ground water of Bargarh district, Orissa. Int. J. Res. and Rev. in. App. Sci., **2**(3): 284-295.

Malhotra P., Bhatnagar A. and Chopra G., 2014. Phytoplankton diversity of Western Yamuna Canal and River Yamuna in Yamunanagar, Haryana International Research Journal of Environmental Sciences, **3**(2): 1-7.

Meade J.W., 1998. Aquaculture Management (CBS Publishers and Distributors, New Delhi, India) pp. 9.

Mishra A., Mukherji A. and Tripathi B.D., 2009. Seasonal and temporal variation in Physicochemical and Bacteriological characteristics of River Ganga in Varanasi. Int. J. Environ. Res., **3**(3): 395-402.

Onyema I.C., 2010. Phytoplankton diversity and succession in the Lyagbe Lagoon, Lagos. Euro. J. Sci. Res., **43**(1): 61-74.

Pathak H. and Limaye S.N., 2011. Interdependency between physicochemical water pollution indicators: A Case Study of River Babus, Sagar, M.P., India (Analele UniversitaNii and Oradea-Seria Geografie (June) Article No. 211103-515, pp 23.

Rai R.K., Upadhyay A., Ojha S.P. and Singh V.P., 2012. The Yamuna River Basin: Water Resource and Environment. Springer, Water Science and Technology Library, Book, 144 p.

Rajasegar M., 2003. Physicochemical characteristics of the Vellar estuary in relation to shrimfarming, J. Environ. Bio., **24**(1): 95-101.

Sirohi S., Sirohi S.P.S. and Tyagi P.K., 2014. Impact of industrial effluents on water quality of Kali River in different locations of Meerut, India. Journal of Engineering and Technology Research, **6**(4): 43-47.

Tare V., 2012. Floral and Faunal Diversity in River Yamuna-Yamnotri, Allahabad. GRBMP-Ganga River Basin Management Plant by IIT. Report Code : 034.

Trivedi R.K. and Goel P.K., 1984. Chemical and Biological Methods for Water Pollution Studies (Environmental Publications, Karad).