Available online at www.ijpab.com

ISSN: 2320 – 7051
Int. J. Pure App. Biosci. **2 (2):** 102-105 (2014)

Research Article

INTERNATIONAL JOURNAL OF PURE & APPLIED BIOSCIENCE

Evaluation of Physico-chemical characteristics and microbial contamination in drainage channel of Gola river water at different distance gradients

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ABSTRACT

River Gola originates from Kumaun Himalaya and flows into mountains for several kilometers and descends down into the plains where it starts getting polluted due to the major pollution load contributed by the effluents of the Lalkuan-based Century Pulp and Paper Mill (Uttarakhand). The value of BOD (300 mgl^{-1}), COD (812 mgl^{-1}), TDS (1460 mgl^{-1}), TSS (580 mgl^{-1}), chloride (775 mgl^{-1}), E.C.(1185μs /cm^{3}), pH and turbidity and microbial population (E. coli)(300/100ml) of water were very high at the point of onset of waste and decreased with increasing distance from the source. In this study we planned to estimate the pollution load generated by the paper and pulp industry in water at different distances (0-17 km) and possibilities of the natural water purification in course of its passage with distance and time.

Key words: *Gola river, pulp and paper mill, effluent, BOD, E.coli.*

INTRODUCTION

One of the very specific roles of the fragile mountains of the Himalaya is that they provide origin to a very large number of rivers and streams, both glacier-fed and rain-fed. Water is not only the utmost physiological necessity of life, but also serves as one of the basic needs of daily activities of mankind and stays as one of the potent symbol of socio-economic development and human happiness. India's situation will be worse as it is amongst 34 countries of the world, which are likely to face severe water shortage problem by the year 2025[1]. Water is a vital factor of life and is a great gift of nature. Himalayan rivers are especially of great ecological, social, cultural and economic importance. Our rivers, unfortunately, are getting increasingly polluted. Polluted rivers are slowly poisoning the land, livestock and human populations.

River Gola, originates in the Kumaun Himalaya, is a rain-fed river. After covering a long journey and reaching to the plains it gets polluted due to major pollution load contributed by the effluents of the Lalkuan-based Century Pulp and Paper Mill[2]. The river Gola is fed by the drainage channel with the pulp and paper mill effluents from the major channel called Kicchha Naala. Pollution load at distance gradients in this small tributary of the river Gola has been studied through the evaluation of the physical-chemical properties of the water flowing into this tributary.

MATERIAL AND METHODS

Location of the Pulp and Paper Mill and Outlet of Effluents

The Pulp and Paper Mill is located about eight kilometers northeast of the Pantnagar University at the township of Lalkuan (Uttarakhand). The effluents of the mill flow out into a drainage channel locally called Kichha Naala that passes through the villages of Bindu Khatta, Jawahar nagar, Shantipuri, Anandpur, Kanakpur, Chhinki and finally, after covering about 18 km distance, joins the river basin.

Sample Collection

The samples of water receiving effluent were collected in the clean plastic containers. The first sample was collected from the point of effluent discharge in the drainage channel. The subsequent samples were collected from different distances of the channel.

Physico-chemical and microbial estimation

Physico-chemical analysis of water, collected from different distances of the drainage channel outside factory, was carried out with respect to electrical conductance, pH, DO, BOD, COD, TSS, TDS, Chloride content and bacteriological (*Escherichia coli*) population[3].

RESULTS AND DISCUSSION

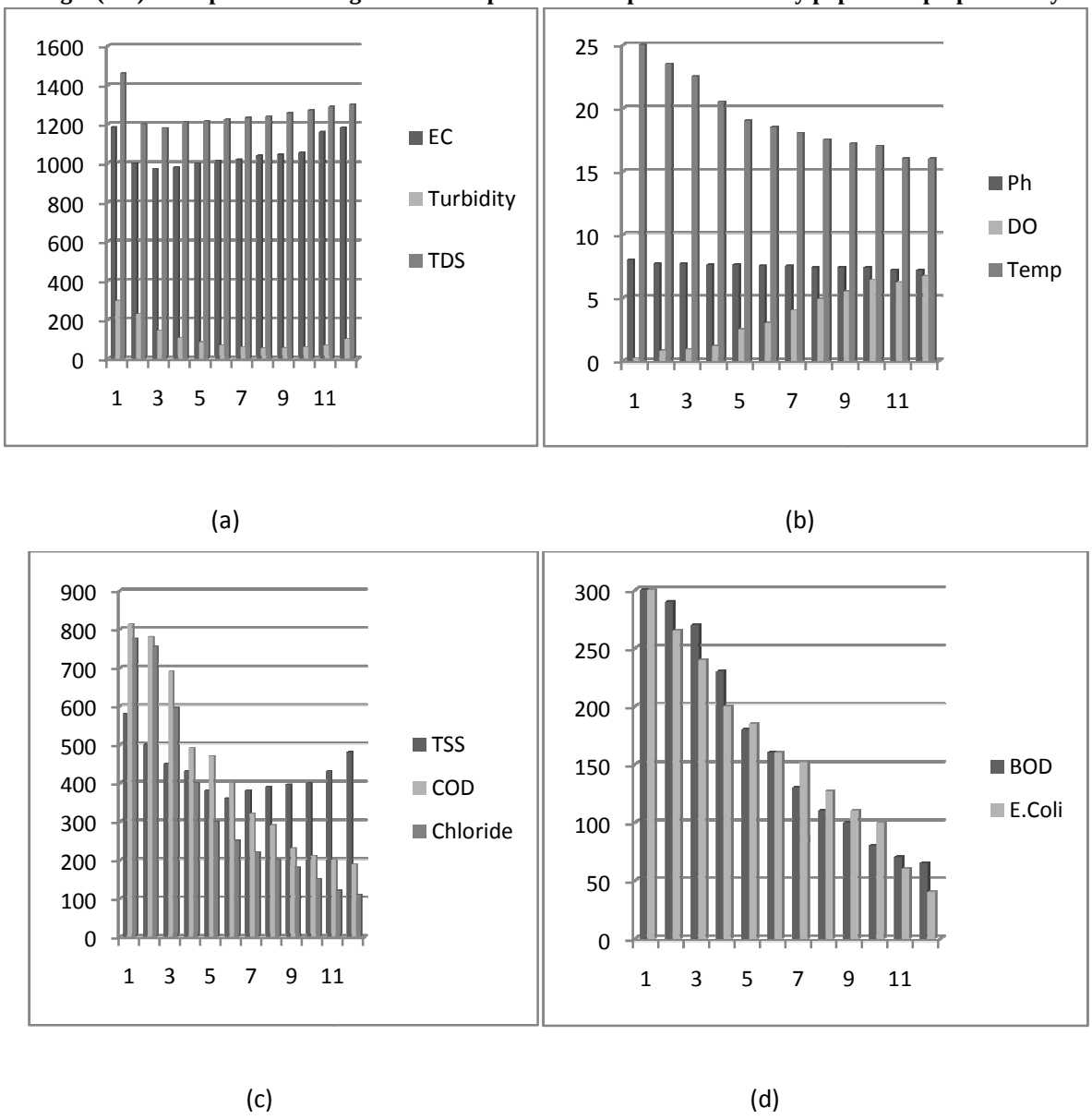
Colour of the water receiving from mill effluent was dark brown at the point of entry into the channel. This colour persisted almost throughout the flow of water in the channel. The temperature of the water near the point of receiving effluent was 25^0C and at the point of the discharge in to basin, it was observed 16^0C.

Table 1: R^2 (Correlation coefficient) values between water properties and distance along the river flow

Distance (km)	Temp (^{0} C)	pH	Turbidity (NTU)	EC µs /cm^3	DO mg/l	TSS mg/l	TDS mg/l	BOD mg/l	COD mg/l	Chloride mg/l	*E.coli* /100 ml
R^2	0.800	0.85	0.552	0.248	0.951	0.08	0.02	0.882	0.824	0.725	0.936
0	25	8.0	298	1185	0.2	580	1460	300	812	775	300
1	23.5	7.7	228	1000	0.8	500	1200	290	780	755	265
2	22.5	7.7	145	970	0.9	450	1180	270	690	595	240
3	20.5	7.6	106	980	1.2	430	1210	230	490	400	200
4	19	7.6	85	1000	2.5	380	1215	180	470	300	185
5	18.5	7.5	70	1014	3.0	360	1225	160	400	250	160
7	18	7.5	60	1020	4.0	380	1233	130	320	220	152
9	17.5	7.4	52.8	1039	4.9	390	1240	110	290	200	127
11	17.2	7.4	55	1043	5.5	396	1257	100	230	180	110
13	17	7.4	60	1055	6.4	400	1270	80	210	150	100
15	16	7.2	70	1160	6.2	430	1290	70	200	120	60
17	16	7.2	100	1183	6.7	480	1300	65	189	120	40

pH value of the effluent channel water at its entry point was 8.0 (Table 1). No specific change in the trend of pH value was observed. The highest value of the turbidity (298 NTU) was recorded near the dumping of the waste in to the channel where pulp and paper mill effluents got mixed with the water. Electrical conductance of water at onset of effluent was observed 1185µs/cm^3. Whereas, while moving towards the end of the channel of the basin, it was slightly decreased and was found 1183 µs/cm^3. However, DO (dissolved oxygen) value was observed very low (0.2 mgl^{-1}) at the point of entry of waste to the channel but increased linearly while reaching 13 km (6.4 mgl^{-1}) away from the source of effluent discharge. The TSS (Total suspended solid) of the water receiving effluents near the entry point was found 580mgl^{-1}. However, reaching at 6 km distance away from source it was observed 350mgl^{-1} in the effluent channel. Likewise, TDS (total dissolved solid) value was found 1460 mgl^{-1} at the entry point of effluent and decreased linearly along the way and was reported 1399 mgl^{-1}near the basin. BOD (Biological oxygen demand) was observed 300 mgl^{-1} (near the origin of the channel) (Fig.1 (d)) and its value decreased constantly up to 17.0 km (65 mgl^{-1}). Chemical Oxygen demand of the water at origin of Pulp and Paper mill effluent received, was 812mgl^{-1} and found reduced with distance to the downstream (189 mg/L at 17 km distance from the source of pulp and paper industry). Similarly, the chloride content of water at the initial point of channel was 775mgl^{-1} which reduced continuously downstream up to the distance of 15 km (120mgl^{-1}). All the water samples collected from the drainage channel were found positive in *Escherichia coli* count. The maximum *E. coli* count was near the dumping site of the effluent source (300/100ml).

Fig.1 (a-d): Comparison among the various parameter of polluted water by paper and pulp industry



The result depicted that among the various physico-chemical, and biological parameters; temperature, DO, BOD, COD, Chloride and *E. coli* count showed significant variation throughout the drainage channel. The dissolved oxygen increased with increasing distance as observed by correlation co-efficient (R^2 0.951) (Table 1). Likewise, Biological oxygen demand was positively co-related (R^2 0.882) as with increasing distance the dilution of the waste took place. Similarly, pH (R^2 0.854) of water was also positively co-related as at the end of the drainage channel, it became almost neutral and useful for agricultural use[4]. However, Total dissolved solid (R^2 0.008) and total suspended solids (R^2 0.080), were negatively co-related because negligible changes were observed in the concentration along the way and at the end of the basin. A positively co-relational was also observed (R^2 0.800) between temperature and distance covered by the drainage channel[5]. Similarly, chemical oxygen demand (R^2 0.824) and *E. coli* count (R^2 0.936) also showed their positive co-relation with increasing distance of the river basin from the pollutant source[6]. Since all along the way in its movement the drainage channel might have received maximum opportunity to get revive. The change in bacteria count might also be affected by pH since *E. coli* generally grow in neutral and slightly alkaline conditions. It is why *E. coli* count was higher at initial sites due to higher pH of the waste water. However, turbidity (R^2 0.552) and EC (R2 0.248) were marginally affected all along the way as observed by co-relation co-efficient.

CONCLUSION

Based on the physical, chemical and biological indicators, it could be concluded that waste water purifies itself to certain extent as it flows along a greater distance from the polluted source. The process of self purification is affected by a combination of various factors such as dilution, dispersion, sedimentation, sunlight etc. Greater purification was supported by the results obtained in the observation of DO, BOD, COD, *E. coli* count of polluted water. However, the colour of the waste water, TSS, TDS, EC and pH, did not improve at all.

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