Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 930-933

Received: 13-03-2019
Accepted: 15-04-2019

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Evaluation of Physio-chemical, microbiological and enzymatic characteristics of water of river Ganga and Yamuna at Prayagraj Allahabad

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Abstract
Rivers are Lifeline of any country. They have a very important role in the economy of a country and welfare of its society. Water quality of the river is one of the major factors in determining the health status of peoples and environment; as water is an essential ingredient for health and hygiene. The present study was carried out at the junction of Sangam in Prayagraj, which is famous as Terath Raj Prayag in Hindu mythology. In the present study samples from river Yamuna and Ganga were studied for the various parameters such as pH, temperature, TDS, TSS, Electrical conductivity, Acidity, Alkalinity, DO, BOD, COD, chloride concentration and Productivity of water. The total bacterial count was done by SPC method, catalase and peroxidase enzyme activity was estimated. Most of the assessed physical and chemical parameters were found to be above than permissible limits of WHO and CPCB. The microbiological parameters confirmed presence of high level of total bacterial count in the rivers. Enzymatic characteristics of water was assessed in order to measure capability of water to self-purify naturally in respect to various factor affecting the activity of enzyme in self-purification of water.

Keywords: Dissolved oxygen, biological oxygen demand, productivity, catalase, peroxidase

Introduction
Rivers play a major role in assimilating industrial and municipal waste water, manure discharge and runoff water from agricultural fields, roadways and streets which are responsible for river pollution [10]. Rivers constitute the main water resources in inland areas for drinking, irrigation and industrial purpose [8]. The Gangetic basin is the largest river system in India, draining almost a quarter of the country. The Ganges basin is the most heavily populated river basin in the world, with over 400 million people and a population density of about 1,000 inhabitants per square mile. A large population of human and animals are directly and indirectly dependent on Ganga for drinking, bathing, agricultural & industrial purposes [2]. The river Yamuna is the largest tributary of river Ganga in northern India. This river is as prominent and sacred as the great river Ganga itself. It merges into Ganga at Triveni Sangam. Surface waters are the most vulnerable to pollution due to their easy accessibility for disposal of waste waters [7]. Yamuna not only flows in the hearts of Indian but also plays a significant role in the economy of the country. River Yamuna and Ganga at Prayagraj have a great reason for concern and attention for research and water quality assessment.

In spite of several measures taken by government and various NGOs there is a heavy increase in the pollution of these rivers are reported every year. High pollution load in river system alters the amount of various constituents in river water like increase or decrease in TSS, TDS, electrical conductivity, BOD, COD, alkalinity, acidity, productivity, DO, pH, temperature, chloride ion concentration, bacterial population, yeast and fungal population, Effect of chlorination on bacterial population and activity of enzyme in self-purification of water etc. Dissolved oxygen (DO) is of great importance to all living organisms and is considered as sole parameter which to a large extent can reveal the nature of whole water body. BOD and COD are parameters to measure amount of organic organic and inorganic compounds in water. Organic and inorganic stress on rivers is reflected in active microbial growth [5]. and changes in physicochemical parameters [1]. Productivity of water is an important parameter which explains ability of water to help in agriculture production. Productivity is obtained in mg $cm^{-3}day^{-1}$. pH is very important parameter as rise in pH increases the solubility of toxic chemicals which can be proved harmful to aquatic fauna.

Catalase and peroxidase is an enzyme which is produced by various microbes and plants etc. as a result of natural process in the river water and these enzymes have capability to self-purify water by catalysing conversion of hydrogen peroxide to oxygen and water. Hydrogen peroxide is formed due to free radicals and increased pollution. Catalase is constantly in battle against the effect of free radicals. It transforms harmful superoxide radicals to hydrogen peroxide which later breakdown to water & oxygen. Peroxidases are enzyme which catalyses the oxidation via H_2O_2 of many organic compounds namely Amines, Hydroquinone etc. These compounds are pollutants found in rivers. Increased pollution causes various harms to life of people & responsible for various dangerous diseases. So, assessment of water quality and follow effective measures to overcome the problem is need of our environment. Keeping these facts in view the present study was conducted to assess the river water quality of Ganga and Yamuna.

Materials and Methods

Water samples were collected in sterilized jars on a monthly basis during January to April. The two different locations of Ganga were considered as Ganga sample-1 (near Shastri bridge) and Ganga sample- 2 (near Sangam area), Yamuna samples (Shyama Prasad Mukharjee Bridge known as New Yamuna bridge). Temperature of water was obtained from flowing stream at the time of sample collection. Water samples were collected directly from rivers using clean stoppered polythene bottles and samples were preserved in a refrigerator.

Physical and chemical analysis

The different physical and chemical analysis were for pH, TDS, TSS, Electrical conductivity, DO, BOD, COD, Alkalinity, Acidity, Chloride ion concentration, and productivity of water were analysed. All the parameters were studied following standard methods [11].

Microbiological analysis

Total bacterial count was checked by spread plating serially diluted sample on Nutrient agar plates, yeast and molds count were checked by inoculating diluted sample on Potato dextrose agar media and colonies were counted after 24 hours incubation. Effect of chlorination on microbial population was also checked following standard procedure [10]. inoculating serially diluted sample on nutrient agar media plate and incubating at 37^0C for 24 hours. Yeast and molds colonies were calculated by growing serially diluted sample on PDA media [10].

Enzymatic analysis

Peroxidase and catalase were assayed according to standard methods [6]. The effect of the time period on catalase activity in three water samples were checked by taking absorbance of prepared sample at a fixed interval of time and plotting standard graph between absorbance Vs time period and absorbance was taken at 500nm.

Results and Discussion

Table 1: Result of Physical and chemical parameters and their comparison with standard permissible limit of WHO, CPCB BIS.

Sample	pH	Temp.	TDS mg/l	TSS mg/l	EC m mho/cm	DO mg/ L	BOD mg/L	COD mg	Acidity mg CaCO3/ L	Alkalinity mg CaCO3/L	Cl^- mg/L	Productivi ty- Mg cm- $3day^{-1}$.
Ganga-1 (near Shastri bridge)	7.39	31^0C	4000	6000	6.25	5.48	1.76	33.6	160	1200	104.37	144
Ganga-2 (near Sangam area)	7.84	31^0C	3999	6800	6.24	4.92	2.32	33.8	150	1300	115.30	162
Yamuna (New Yamuna bridge).	8.25	33^0C	8000	4000	12.5	5.94	2.72	30.8	160	1050	146.11	324
Standard Permissible limits												
BIS	6.5-8.5	-	-	-	-	5	-	-	-	-	250	-
WHO	7-8.5	<32^0C	1000	100	600	>5	<2	<10	-	-	250	-
CPCB	6.5-8.5	-	2100	-	2250	>6	<3	-	-	600	250	-

***** The above values are the mean value from January – April 2018

Table 1 shows the physic-chemical characteristics of Ganga 1, Ganga 2 and Yamuna waters from the study area. The pH values are in the range 8-9, within the permissible limits (6.5-8.5) as prescribed by BIS, WHO and CPCB. On the other hand, temperature are varied in the range from 31^0C- 33^0C. TDS and TSS Values are in the range from 4999- 8000mg/l and 4000-6800 mg/l respectively.EC values are varied in the range from 6.24-6.12.5 µ mhos/cm and all are below the permissible limits (600-2250 µ mhos/cm) by WHO and CPCB. DO (4.92-5.94mg/l) and BOD (1.76-2.72mg/l) values all are within permissible limits (5-6mg/l) and 2-3mg/l). The COD level (30.8-33.8 mg/l) in all the three studied water samples found exceeding the permissible limits (<10 mg/l) which shows there were higher amount of inorganic and organic matter present together in Ganga and Yamuna water samples. Acidity values are in the range 150-160 mg/l where alkalinity values are in the range (1050-1300 mg/l), which is above the permissible limits (600 mg/l) as prescribed by CPCB. The amount of dissolved CO_2 in G1-660 mg $CaCO_3L^{-1}$, G2-374 mg $CaCO_3L^{-1}$, Dissolved CO_2 was absent in Yamuna. Alkalinity or buffering capacity was very high in all the samples. Acidity of Yamuna and Ganga sample- 1 were same. The chloride concentrations are in the range (104.37-146.11 mg/l) which is below the permissible limits (250 mg/l) as by BIS, WHO, CPCB. Productivity of Yamuna water was higher than the Ganga water and there was only a slight variation in productivity of two samples of Ganga river was noticed.

The microbial analysis was done by standard methods. The organisms were found 3.2 x 10^5 cfu/ml of sample in Ganga sample-1, 4.4 x10^5 cfu/ml of Ganga sample-2, and 8.2 x 10^5 cfu/ml of sample in Yamuna water samples. Potato dextrose agar is a selective medium used for the cultivation of yeast and molds. The use of Potato extract promotes growth of yeast and molds, and the low pH helps to inhibit the growth of bacteria while favouring the growth of yeasts and molds. Yeast and molds population 4 x 10^4cfu/ml of water sample in Ganga-1, 2 x 10^4 cfu/ml of water sample in Ganga-2, 3 x 10^4 cfu/ml in Yamuna. Effect of chlorination on water sample was checked by treating sample with 9ppm, 12.5ppm, 15ppm sodium hypochlorite solution and inoculating treated sample on a NA media plate and comparing the growth with a control plate containing untreated water sample. It was found that with increase in the amount of sodium chlorite in the sample there was high decrease in microbial population as shown in Figures 1, 2 and 3.

Fig 1: Microbial colony of Yamuna population on NA plate.

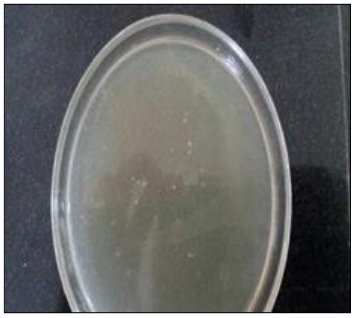


Fig 2: Microbial colony of Ganga sample on NA plate.

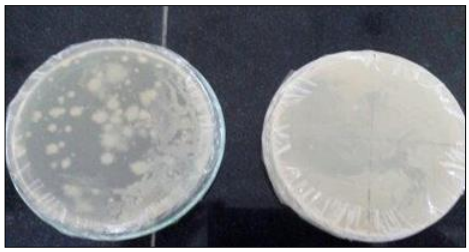
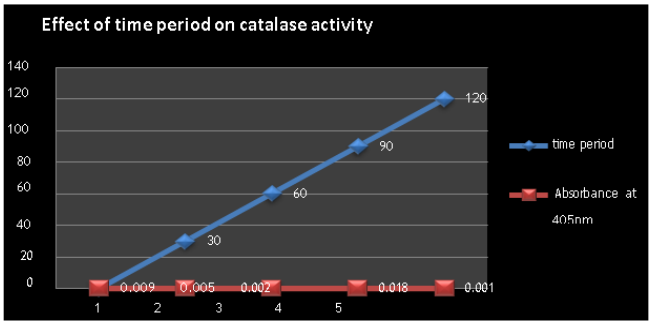
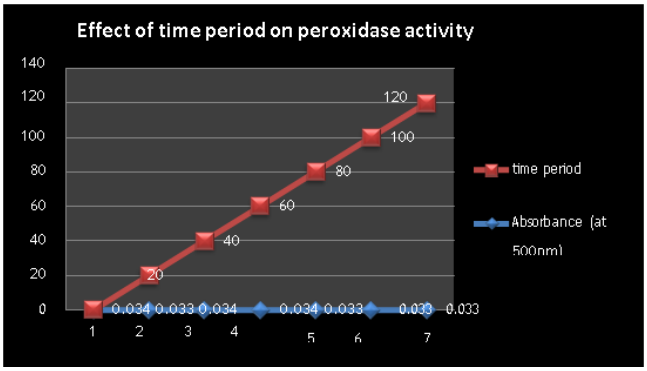


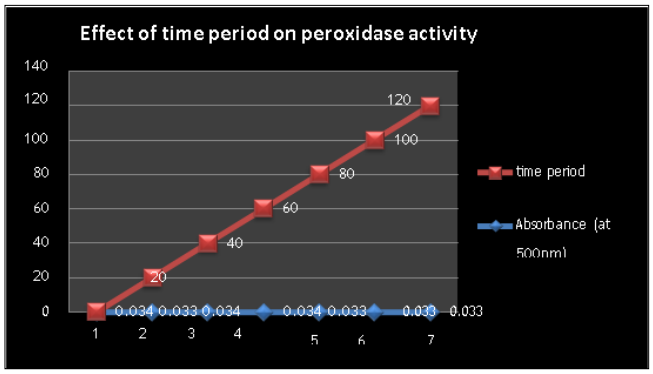
Fig 3: Effect of chlorination on microbial water Untreated &treated sample grown NA media plates.

Enzyme analysis

The Presence of Catalase was confirmed in all the three samples by following the standard procedure mentioned above. It was found that catalase activity in Ganga sample-1 was 1269.07 Kilo Units/Litre, in Ganga sample-2 1403.70 Kilo Units/L, and in Yamuna sample it was 1348.39 Kilo Units/L. The presence of peroxidase was assumed and experiment was performed on the basis of Null and Alternate Hypothesis mentioned above in materials and methods. Enzyme activity was measured by using a spectrophotometer by recording change in coloration of Guaiacol to brown, indicated that hydrogen peroxide was completed. It shows the action of peroxidase enzyme in sample. This absorbance of solution shows reaction or activity of peroxidase enzyme in decomposition of hydrogen peroxide in the sample. The effect of time period, effect of pH and effect of enzyme concentration on peroxidase activity was showed in Figure 4.







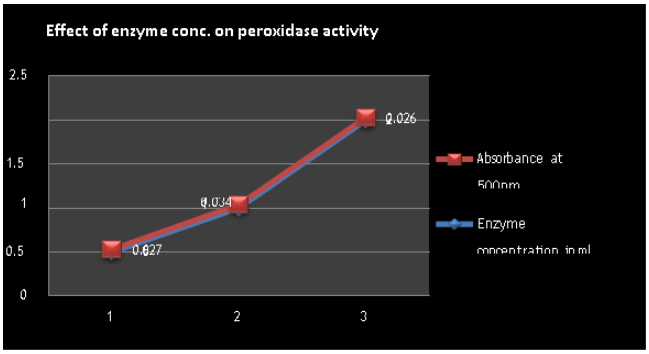


Fig 4: Effect of various factors on peroxidase and catalase activity in river water samples

The Present study on three different sampling locations in Prayagraj (Allahabad) was carried from January –April 2018. The study represents that despite of the continuous efforts of government to minimize the river pollution. The present status of the quality of water of these two holy rivers of north Indian is not good as per standard norms. Increased level of pH and temperature of Yamuna was higher than standard limit shows deterioration in quality of Yamuna water as rise in pH increases the solubility of toxic chemicals which can be harmful to aquatic fauna, similarly high pH particularly in combination with high water temperature, can increase the amount of unionized ammonia which is highly toxic to fish. In the present study it was observed that by filtration or removal of suspended solids from the water, slight decrease pH of water can be obtained. Fluctuating amount of various measured parameters like TDS, TSS, DO, COD, Alkalinity, Acidity etc. in water confirmed presence of heavy pollution load in the river water of both the rivers. TSS, TDS, BOD, COD, Alkalinity, Acidity was higher in Ganga water than Yamuna water & DO in Ganga is less than DO in Yamuna. It indicates that pollution level in Ganga is more than pollution in Yamuna at Prayagraj (Allahabad) but increased pH and temperature of Yamuna than permissible limit is harmful for aquatic flora and fauna in Yamuna more than Ganga water.

High microbial population was reported in Yamuna in comparison to both the samples of Ganga and BOD of Yamuna was also higher than BOD of Ganga which confirmed presence of heavy amount of organic matter in Yamuna. Study confirmed that in spite of all these heavy pollution load productivity of Yamuna was higher than that of Ganga sample-1 and Ganga sample-2. Presence of naturally occurring catalase and peroxidase enzyme was reported which shows ability of water to self-purify. Activity of enzyme catalase increases with increase in time up to certain level. And change in temperature has similar effect on peroxidase enzyme was also noticed. With increase in enzyme concentration activity of peroxidase enzyme increased & increase in pH also have similar effect on activity up to certain level. More increase or decrease in pH degrades enzyme activity. Due to increased pollution naturally occurring catalases and peroxidases are not sufficient to purify river water completely, So by adding enzymes from outside the river in a controlled manner with in a standard permissible limit range can be one of good options to treat river water in order to reduce pollution load. But using enzyme for pollution control people should be aware of the fact that catalases and peroxidases have adverse effect on life which causes hazards diseases when present in excess amount, so, amount/activity of enzyme should be always checked before adding to the stream. More and more plantation will also help in improving quality of water because due to loss of plants there is gradual increase in amount of CO_2. Increased atmospheric carbon dioxide leads to increase in lowering of water pH, which causes death of aquatic organisms.

Conclusion

In the present study on enzyme activity and factors affecting enzyme activity was observed. Catalase and peroxidase activity in all the water samples were indicated that the river possess the capacity of self-regeneration due to sustainable bacterial population. Various factors like variable weather, pH etc. leads to change in activity. It was found that despite of the continuous efforts to minimize the pollution; pollution load is increasing which is deteriorating the water quality of river Yamuna and Ganga.

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