RESEARCH ARTICLE

Effect of Increasing Sewage Waste on the Population of Some Microbes of River Yamuna

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Received: 02 February 2017/Revised: 02 March 2017/Accepted: 23 April 2017

ABSTRACT- A study was carried out to assess the pollution load in river Yamuna at Mathura (U.P.) and its impact on the population size of some aquatic microbes. The key indicators of sewage waste load were Coliform count (MPN), BOD, sulphates, chloride and ammonia. The susceptible microbes that analyzed included *Ulothrix*, *Paramecium* sp. *Difflugia* sp. and species of *Cyclops*. The study revealed that the river is very badly polluted, especially with sewage, garbage and effluents from the city and local industries. The population of Coliform bacteria and *Ulothrix* (algal organisms) was found very high in those areas, where organic pollutants were very high amount. But other organisms like, *Paramecium* sp. *Difflugia* sp. and *Cyclops* exhibited a severe decline in population count, indicating heavy pollution load, especially during summer months.

Key-words- BOD, Coliform bacteria, Pollutants, Sewage waste

INTRODUCTION

River Yamuna is one of the ancient holy rivers of India. It has got a great religious and aesthetic value. It originates from Yamunotri in the Himalayan region (Uttaranchal), flows through western and southern Uttar Pradesh and finally drains into the holy Ganga River at Allahabad. During its great course, it also flows through District Mathura (in western U.P.)

Mathura was selected as study area as it is considered to be a historical and sacred place, being the birth- place of Lord Krishna. Millions of pilgrims from every corner visit Mathura every year and take bath in the holy river Yamuna. The sewage along with the garbage is disposed off either directly or indirectly into the Yamuna, through a number of wide drains and results in heavy water pollution [1].

The sewage waste is especially rich in Coliform bacteria (Gram negative lactose fermenting rods). Besides these, microbes like enterobacter, micrococci, lactobacilli, facultative clostridia and streptococci also predominate during early stages of sewage decomposition [2]. Excessive entry of sewage in the river interferes with the natural decomposition process, leading to accumulation of organic matter, which is detrimental for aquatic biota [3].

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Quick Response Code

Website: www.ijlssr.com

DOI: 10.21276/ijlssr.2017.3.3.24

Further, Mathura is a growing industrial hub. A large number of cotton printing industries and silver vibrators are working here. Their effluents are being mixed directly in the river, creating a huge ecological stress. Though, the Government has made it compulsory to treat the waste water before its disposal, many small-scale industries are still not having such water treatment plants. Due to severe river pollution, the life of bath takers, live stock and aquatic organisms is being sacrificed [3].

In the present study, an assessment of pollution load in river Yamuna and simultaneous recording of fluctuations in the population count of some aquatic microbes was carried out. The study clearly revealed that increasing pollution load greatly affects the population of these microbes.

MATERIALS AND METHODS

The one year study (January 2016 to December 2016) was carried out in the Department of Zoology, B.S.A. College, Mathura. For the collection of sample of river water following three sites were selected- **a.** Site A (Upstream), **b.** Site B (Middle), **c.** Site C (Downstream).

Site A is located near All India Radio (AIR) station. Site B passes through the middle of the city, while site C is located near Gokul barrage. The sites were selected to compare the entry and exit loads so that the pollutant addition from the city could be assessed.

Sampling

Water sample of river Yamuna was taken in 15th of every month (January 2016 to December 2016) between 7.00 A.M. to 8.00 A.M. For BOD, the sample was taken in BOD bottles. Parameters like pH, BOD, ammonia, chloride and

sulphate were tested in the laboratory according to standard methods, prescribed by APHA [4].

Some common microbes, present in river water were also considered as test organisms [5]. These included Coliform bacteria, species of *Ulothrix, Paramecium, Difflugia,* and *Cyclops*.

The water sample for determining the population of these organisms were taken separately in 1 liter glass bottles. Samples were preserved at 4ºC in 4–5 % buffered formalin solution.

Population assessment

The population of Coliform bacteria was determined by MPN technique. For other organisms, microscopical counting method was used [4]. The sample was concentrated using planktonic nets of different sizes and was then stored in a closed and labelled glass vials. It was mixed properly by thorough shaking and 0.5 ml of the sample was pipetted with a fractional pipette on a clean glass slide. The slide was examined microscopically. Counting and enumeration were done with the help of an occular micrometer. The entire procedure was repeated thrice for each sample and then averages were noted for more reliable results.

RESULTS

The pH was found to be in normal permissible range. It was higher (slightly more alkaline) in the summers than in the winters. But other physico-chemical parameters such as ammonia, chlorides and sulphates were found to be very high, indicating high degree of organic load, especially in summers. BOD reached up to 126 mg/L in June at site B, which indicates the accumulation of large amounts of organic matter in the river.

The Coliform count was again very high summers (36.8 x 1000 units in June at site B). It was comparatively lower in winters. *Ulothrix* exhibited a better growth in water with high organic matter, whereas other test organisms showed a decline in their population.

The monthly observations for physico-chemical parameters and for population count have been shown (Table 1).

Table 1: Physico chemical parameters and population count of test organisms

Parameters/ Microbes	Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pH	A	7.8	7.9	7.5	8.2	8.5	8.5	8.6	8.2	8.3	7.9	8.0	7.6
	B	7.6	7.8	7.2	8.1	8.6	8.2	8.4	8.1	8.1	8.0	8.1	7.8
	C	8.0	8.1	7.9	8.3	8.5	8.8	8.8	8.4	8.0	8.1	7.8	8.2
BOD (mg/L)	A	41	58	63	81	101	115	105	95	78	69	54	44
	B	58	64	69	91	118	126	119	108	89	74	67	57
	C	46	59	67	89	98	110	108	98	83	62	58	51
Ammonia contents (mg/L)	A	0.29	0.38	0.31	0.45	0.69	0.85	0.81	0.83	0.69	0.52	0.49	0.33
	B	0.38	0.51	0.65	0.68	0.79	0.96	0.87	0.78	0.79	0.65	0.47	0.42
	C	0.34	0.41	0.58	0.69	0.72	0.95	0.92	0.89	0.75	0.66	0.41	0.39
Chloride contents (mg/L)	A	35	38	42	56	69	72	75	51	60	48	52	41
	B	51	67	70	79	89	85	82	59	68	52	50	46
	C	44	54	62	69	87	89	85	70	61	55	48	36
Sulphates (mg/L)	A	562	630	498	580	770	861	814	778	714	681	701	645
	B	603	595	641	650	715	987	924	828	721	737	740	680
	C	587	605	584	619	709	847	907	837	747	709	685	621
Total Coliform (MPN)x1000	A	19.5	18.6	22.4	24.5	28.4	31.5	35.2	29.5	25.4	22.6	24.9	19.1
	B	24.1	22.8	25.6	27.4	32.5	36.8	30.5	30.8	27.4	26.5	27.6	25.8

	C	22.5	23.5	25.8	29.4	31.4	34.1	29.5	31.5	28.1	25.4	22.4	20.8
	A	22	28	45	67	84	68	75	69	62	56	70	37
Ulothrix sp.	B	38	45	77	68	94	108	95	81	60	76	67	42
	C	35	42	65	72	82	79	80	69	65	81	52	41
	A	45	32	38	40	31	28	25	34	29	28	42	39
Paramecium sp.	B	38	27	31	22	19	12	18	17	21	19	28	32
	C	40	29	35	25	22	19	18	25	37	27	33	42
	A	18	20	15	10	08	11	15	14	19	17	20	22
Difflugia sp.	B	15	16	18	11	06	04	08	10	09	13	18	16
	C	17	20	22	17	09	08	11	12	15	21	20	15
	A	15	14	11	08	11	08	07	11	13	17	11	14
Cyclops	B	12	14	09	07	02	03	06	11	08	07	12	10
	C	18	16	12	08	07	10	08	10	09	12	16	12

DISCUSSION

The degree of pollution was found to be very high in the middle site B. This is mainly because the site is located near the centre of the city and it receives three wide drains that bring excreta and garbage of the entire city into the river water. Pollution load was also higher at site C as compared to site A. This site is located near the industrial area and it receives two wide drains that pour the effluents of many *saree* printing industries and silver polishing plants.

Seasonally, the pollution load was higher during summer (i.e. May, June and July) at all sites. This is because of the presence of low amount of diluting water in the river [6]. So, the remaining water becomes highly concentrated with pollutants.

Parameters like BOD and ammonia were found to be directly related to pollution load. When the pollution load was high, the values of BOD were found to be very high. This is mainly because dissolved oxygen gets utilised in the oxidation of biological waste and also in the respiration of algae [7].

Ammonia is rapidly oxidised by certain microorganisms in natural water bodies from nitrite to nitrate, a process that requires the presence of dissolved oxygen. So, a high level of ammonia (sewage waste) can severely contribute to high BOD levels. High BOD levels and increased level of ammonia were indicators of heavy sewage (organic) pollution [2].

The values of chlorides and sulphates were also found very high at site B compared to the other two sites. Seasonally, the values were remarkably high during summers. These high values indicated a heavy organic load in the river during summers.

The Coliform population exhibited positive trends with BOD, ammonia, chlorides and sulphates i.e. population was found very high, where the pollution load was high. Therefore, the highest population of these bacteria was recorded at Site B especially during summers. High level of Coliform again indicated the presence of heavy organic pollutants in the river [1]. Coliform produce a bad and offensive smell in the water body. Coliform represented a negative trend with oxygen, probably because absence of oxygen leaves the waste untreated, which is favourable to the bacterial growth [5].

Ulothrix being an alga, showed a luxuriant growth near the banks of the river, mainly due to the accumulation of organic wastes (eutrophication). It exhibited a positive correlation with ammonia, chlorides and sulphates. The high population of algae was the indicator of heavy pollution load in the water body [8].

The population of *Difflugia, Paramecia,* and *Cyclops* showed a negative trend with BOD, ammonia, chlorides and sulphates. In summers, when the pollution load was high, a minimum population was recorded [9]. This clearly indicated that such organisms cannot survive in high BOD environment [2].

Ammonia is the excretory waste of *Difflugia, Paramecia* and *Cyclops*. So these organisms cannot survive in a medium, which has high ammonical contents [10]. Furthermore, low values of dissolved oxygen also cause problems in their respiration [11].

CONCLUSIONS

This study revealed that those sites selected for study are badly polluted by sewage and effluents of many small scale

industries. Site B is the worst affected as it receives the maximum sewage load. Upstream and downstream sites were shown comparatively lesser pollution load. The population of test organisms like *Difflugia*, *Paramecium* and *Cyclops* has shown severe fluctuation, which does not indicate a healthy ecological balance in the river. Besides these statistical figures, some other factors were also observed, which are contributory to the problem. One important factor was the absence of bathrooms and toilets at the banks of the river, where a large number of pilgrims take bath. In the absence of toilets, the pilgrims are forced for open defecation, which further deteriorates the problem. Further, a large number of washer-men were using river water for the purpose of washing their clothes. Most small scale industries, especially those which are engaged in silver polishing work, are passing out their effluents into drains, which open directly into the river. It is compulsory for these industries have water treatment plants; despite most of them do not have such plants. Local administration, pollution control board and municipality are working very poorly without any effective control.

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How to cite this article:

Agrawal P. K: Effect of Increasing Sewage Waste on the Population of Some Microbes of River Yamuna. Int. J. Life Sci. Scienti. Res., 2017; 3(3): 1106-1109. DOI:10.21276/ijlssr.2017.3.3.24

Source of Financial Support: Nil, **Conflict of interest:** Nil

