Effect of covid-19 lockdown on water quality of Mutha river, Pune city.

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Abstract

Mutha river originates, in the Western Ghats about 45 km to the west of Pune city, India. Increasing urbanization coupled with industrialization during the past few decades are depleting aquatic ecosystems. The population of the city is rapidly increasing leading to increasing consumption of water resources. The water quality is constantly deteriorating. Mutha River is polluted due to the discharge of untreated sewage and industrial effluents.

Covid lockdown affected the natural resources differently. Lack of activity and human interference resulted in improvement and upgradation of water quality. In the present study a comparative study of water quality before and after lockdown was undertaken.

Water samples were collected from 20 different locations on Mutha river across the city. Various physico-chemical parameters were checked. Biochemical Oxygen Demand (BOD) is an important water quality parameter as it provides an index to assess the effect that the discharged waste water will have on the receiving environment. A comparative account of BOD values at various locations pre and post lockdown was done to compare the pollution level of Mutha River in Pune city. The result reveals a big decrease in pollution level and hence reflects an increase in water quality.

Key words: Biochemical Oxygen Demand (BOD), river water, Pollution

INTRODUCTION

Studies on quality of river water are essential to protect the natural water resources. When organic matter or sewage is added to water bodies its effects are observed as reduction in oxygen levels and elevated levels of carbon dioxide due to bacterial degradation. The direct addition of nutrients enhances growth of algae and other biological growth, which on death and decomposition, lead to additional reduction of oxygen [1].

As a result of rapid urbanization, industrialization and execution of various developmental activities there has been degradation of aquatic environment, river water quality (RWQ), pollution and health, river ecosystem services in the recent years. The untreated industrial sewage discharged into rivers and the non-degradable agriculture fertilizers pollute the majority of the large world rivers. The toxic materials and excess nutrients supply from agricultural fields gradually decline the river water quality. Around 38,000 million litres per day unprocessed sewage and wastewater released into the Indian River systems according to Central Pollution Control Board (CPCB, 2018) report. Around 52% of unprocessed sewage

and industrial effluents are discharged into rivers of India due to inadequate sewage treatment capacity [2]. (Baisakhi Chakravorty et al, 2021). Pune generates 744 million litres per day (MLD) of waste through sewage and other means. Out of this 177 MLD of waste is entering the rivers without treatment [3].

The significance of nature in our everyday life was shown to the entire world by Covid-19 lockdown situation which also gave a real representation of the overuse of the natural resources. This showed that we are accountable for ruining the nature and putting our welfare to a risk as well. There are several issues due to the lockdown at the front of social and economic wellbeing which cannot be appreciated at all but some positive lessons related to nature gave us a way forward for restraining from the natural calamities if care for nature is established with honesty [2].

The valuation of the various effects of COVID-19 lockdown on our environment has developed as a vast topic of interest for researchers across the world. Our environment has inherent ability to return into its unspoiled form, which was apparently witnessed in the lockdown period. The information on positive impact of lockdown has developed as a probable corrective act for refining the worth of the various environmental possessions [4].

The disproportionate discharge of domestic sewage, industrial effluents from small scale and local industries, has worsened the water quality of River Mutha considerably in the city of Maharashtra, "Pune." In a recent survey carried out by the Maharashtra Pollution Control Board (MPCB) it was found that rivers from Pune carry polluted water. In its recent report the MPCB has reported the water quality of rivers flowing through Pune city as "bad or very bad" [5]. According to MPCB report, domestic waste is also creating pollution in the rivers besides industrial waste. Pune generates 744 million litres per day (MLD) of waste through sewage and other means. Out of this 177 MLD of waste is entering the rivers without treatment [5]. The present study aims to compare the water quality before and after Covid lockdown of River Mutha, Pune, Maharashtra.

A relative evaluation of the water quality is carried out for river water samples taken before COVID 19 lockdown (February 2020), and after COVID-19 lockdown (February 2021). An effort has been made to recognize likely factors that are affecting the water quality.

The Biochemical oxygen demand (BOD) is a pollution parameter mainly to assess the quality of effluent or wastewater. BOD is the amount of oxygen consumed by bacteria and various other microorganisms [6]. (Daoliang et al., 2019) as they act upon the organic matter under aerobic conditions at a specified temperature. This decomposition of organic matter in presence of oxygen is called as the biochemical oxygen demand [7]. The BOD is a test which is used to determine the molecular oxygen used during a specified incubation period (generally 5 days), when the organic matter is degraded (demand) and the oxygen oxidises the inorganic matter like sulphides and ferrous ion. It is a simple and practical indicator of the total organic matter that can be degraded by the organisms. It also indicates any other chemicals that spontaneously react with O_2[8].

To decide the relative oxygen requirements for aqueous microbes to consume organic materials in wastewaters, effluents in wastewater treatment plant, or natural waters BOD_5 has been used as an indicator for the number of organic pollutants in majority of aquatic systems, especially a good indicator for biodegradable organic compounds. The physicochemical characteristics of water bodies have often been studied from time to time. These characteristics help to recognize the causes of pollution, to carry out further research on the

eco-biological effects and also to initiate needed steps for corrective actions in case of polluted water bodies. BOD value in the range of 2 to 8 mg/L indicates a moderately polluted river. When BOD values exceed 8 mg/L rivers may be considered severely polluted(6).

The present study was carried out on 20 samples collected from Mutha river flowing across Pune city and analysed for BOD.

MATERIALS AND METHODS

Sampling

For valid result, care must be taken while collecting a water sample. First, the sample collected must be homogeneous, representative, and acquired without altering microbiological or physicochemical characteristics. [9].

The sterile disposable plastic bottles were used to collect water samples for the BOD analysis and stored at - 4 °C, and should be analysed within 24 h. Samples were collected in the morning, and the sterile collection bottles were held directly and dipped to a depth of 30 to 50 cm from the surface of the water. 20 water samples were collected and analysed in the laboratory.

The present study was carried out on Mutha river flowing across Pune city. Samples were collected from twenty different locations spread from the emergence of mutha river near Khadakwasla and till its confluence with Mula river near Sangam Bridge. Representative sampling sites are shown in the map in the fig 1. In total 20 samples were collected and physical properties observed. BOD was carried out for all the samples .

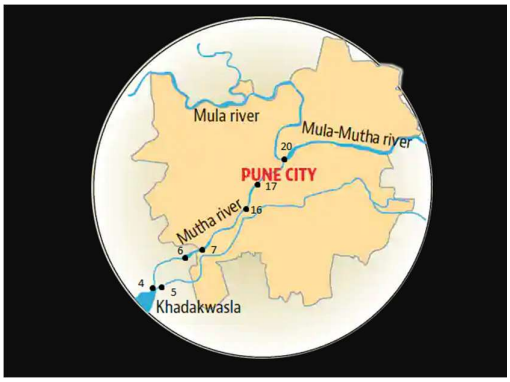

Fig. 1. Mutha river map with sampling sites

Sampling Stations:

Selection of sampling points was based on the objective of monitoring and accessibility. To study the magnitude of pollution, twenty sampling locations were selected in about 15 km stretch of River Mutha.

Sites at Mutha River

(Visual observations while collecting samples)

1-Khadakwasla Dam 1: This is the one of the most unpolluted site on the river Mutha.

2-Khadakwasla Dam 2: This is the one of the most clean site on the river Mutha.

3-Khadakwasla Dam 3: This site shows pollution on the river Mutha.

4-Khadakwasla Door 1: Pollution level decreases as compared to earlier site.

5-Khadakwasla Door 2: Pollution level remains same as Site No 4

6-Nanded city 1: Due to the increasing residential complexes more sewage enters into the river water.

7-Nanded city 2: Due to the increasing residential complexes more sewage is received into the river.

8-Canal (Veer Baji bridge 1):Sewage is added into the river water and water quality remains same as site 7.

9-Canal (veer baji bridge 2): Water quality improves slightly as compared to earlier site.

10-Canal Door: Water quality again deteriorates.

11-Vitthalwadi 1: Due to the growing residential complexes and development of villages, gradually sewage builds up into the river water.

12-Vitthalwadi 2: Water quality remains same.

13-Vitthalwad 3: Water quality remains same.

14-Santosh Hall: Heavy and populated area and water quality remains same.

15-Prayeja city: This site is located at the base of residential complexes, and water quality is very poor with high value of BOD.

16-Mhatre Bridge: The water quality improves slightly at this point .

17- Joshi bridge : Water quality again decreases with high value of BOD.

18- Bhide bridge: Water quality again improves slightly.

19- Shahu setu: Water quality again decreases.

20- Sangamwadi: This is a location on the Mutha river just before the confluence of Mula and Mutha. At this spot offensive odour, exists.

BOD determination: These samples were analyzed for basic physical parameters. BOD determination was done for all the samples extensively. BOD was determined as per APHA (1992).[10].

RESULTS AND DISCUSSION

Table 1. Sample Readings/Results Pre-Lockdown (March 2021)

Sample No	place	pH	Turbidity	colour	DO mg/lit	BOD
1	Khadakwasla dam 1	5	+	-	4.8	11
2	Khadakwasla dam 2	5	+	-	4.4	72
3	Khadakwasla dam 3	5	+	-	4	57.2
4	Khadakwasla door 1	5	+	-	4	17.6
5	Khadakwasla door 2	5	+	-	3.6	13.2
6	Nanded city 1	5	+	-	1.6	39.6
7	Nanded city 2	5.9	+	-	1.6	39.6
8	Canal (veer baji bridge 1)	5	+	-	4.8	39.6
9	Canal (veer baji bridge 2)	5.5	+	-	3.6	22
10	Canal door	5	+	-	4.4	35.2
11	Vithalwadi 1	6	+	-	1.6	72
12	Vithalwadi 2	6	+	-	4	57.2
13	Vithalwadi 3	6	+	-	4	57.2
14	Santosh hall	5	+	-	4	57.2
15	Prayeja city	5	+	-	1.6	72
16	Mhatre bridge	6	++	-	4	57.2
17	Joshi bridge	6	++	-	1.6	72
18	Bhide bridge	5	++	-	4	57.2
19	Shahu setu	5	+	-	1.6	72 mg/lit
20	Sangamwadi	5	+	-	4	57.2

Table 2. Sample Readings/Results Post Lockdown (March 2022)

Sample No	place	pH	Turbidity	colour	DO mg/lit	BOD
1	Khadakwasla dam 1	5.1	+	-	2.4	12
2	Khadakwasla dam 2	5	+	-	2.4	12
3	Khadakwasla dam 3	5	+	-	1.6	4
4	Khadakwasla door 1	5	+	-	0.8	-12
5	Khadakwasla door 2	5	+	-	0.8	-12
6	Nanded city 1	5	+	-	0	-12
7	Nanded city 2	6	+	-	0	-12
8	Canal (veer baji bridge 1)	5.5	+	-	0.8	-12
9	Canal (veer baji bridge 2)	6	+	-	0.8	-12
10	Canal door	5	+	-	1.2	11.9
11	Vithalwadi 1	6.2	+	-	0	-12
12	Vithalwadi 2	6.3	+	-	0	-12
13	Vithalwadi 3	6.4	+	-	0	-12
14	Santosh hall	5	+	-	0.8	-11.9
15	Prayeja city	5	+	-	2	8
16	Mhatre bridge	6.1	++	-	1.6	4
17	Joshi bridge	5.9	++	-	1.2	-4
18	Bhide bridge	5.2	++	-	1.2	-4
19	Shahu setu	5	+	-	1.6	4
20	Sangamwadi	5	+	-	0	-12

Table 3 Comparative Readings/Results of DO and BOD

Sr No	Sample Collection station/ place	Sample Readings/Results PreLockdown (March 2020)		Sample Readings/Results Post Lockdown (March 2022)	
		DO mg/lit	BOD	DO mg/lit	BOD

1	Khadakwasala dam 1	4.8	11	2.4	12
2	Khadakwasala dam 2	4.4	72	2.4	12
3	Khadakwasala dam 3	4	57.2	1.6	4
4	Khadakwasala door 1	4	17.6	0.8	-12
5	Khadakwasala door 2	3.6	13.2	0.8	-12
6	Nanded city 1	1.6	39.6	0	-12
7	Nanded city 2	1.6	39.6	0	-12
8	Canal (veer baji bridge 1)	4.8	39.6	0.8	-12
9	Canal (veer baji bridge 2)	3.6	22	0.8	-12
10	Canal door	4.4	35.2	1.2	11.9
11	Vitthalwadi 1	1.6	72	0	-12
12	Vitthalwadi 2	4	57.2	0	-12
13	Vitthalwadi 3	4	57.2	0	-12
14	Santosh Hall	4	57.2	0.8	-11.9
15	Prayeja city	1.6	72	2	8
16	Mhatre bridge	4	57.2	1.6	4
17	Joshi bridge	1.6	72	1.2	-4
18	Bhide bridge	4	57.2	1.2	-4
19	Shahu setu	1.6	72	1.6	4
20	Sangamwadi	4	57.2	0	-12

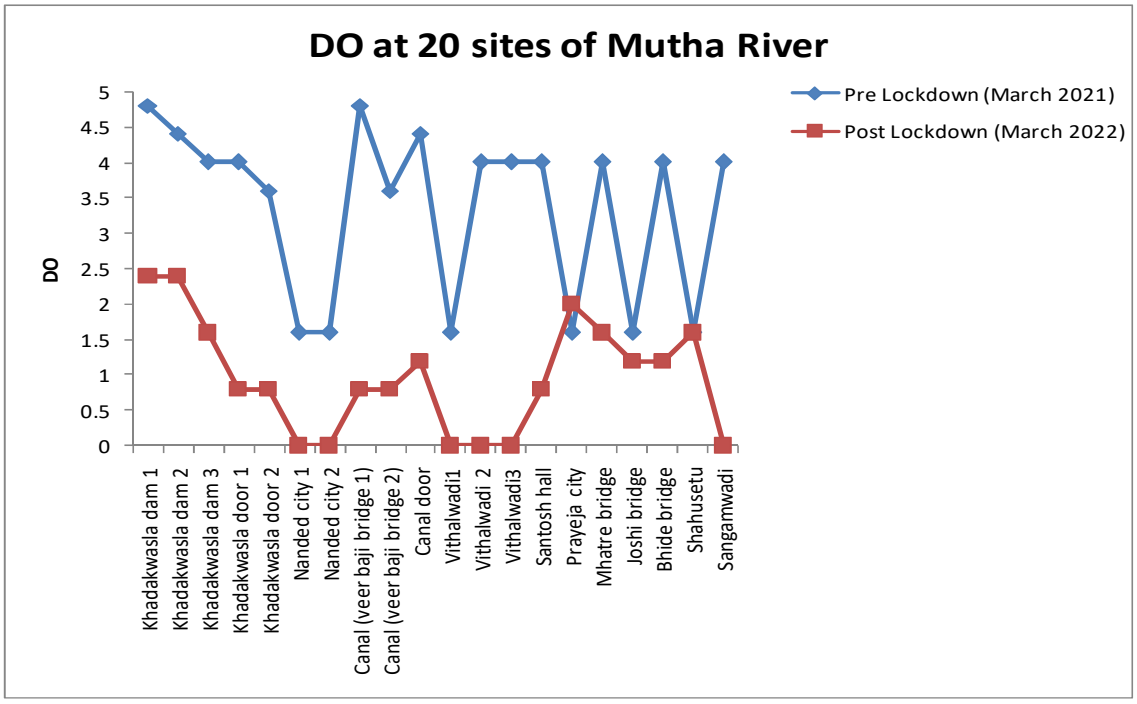

Fig 2 DO at different sites of Mutha River

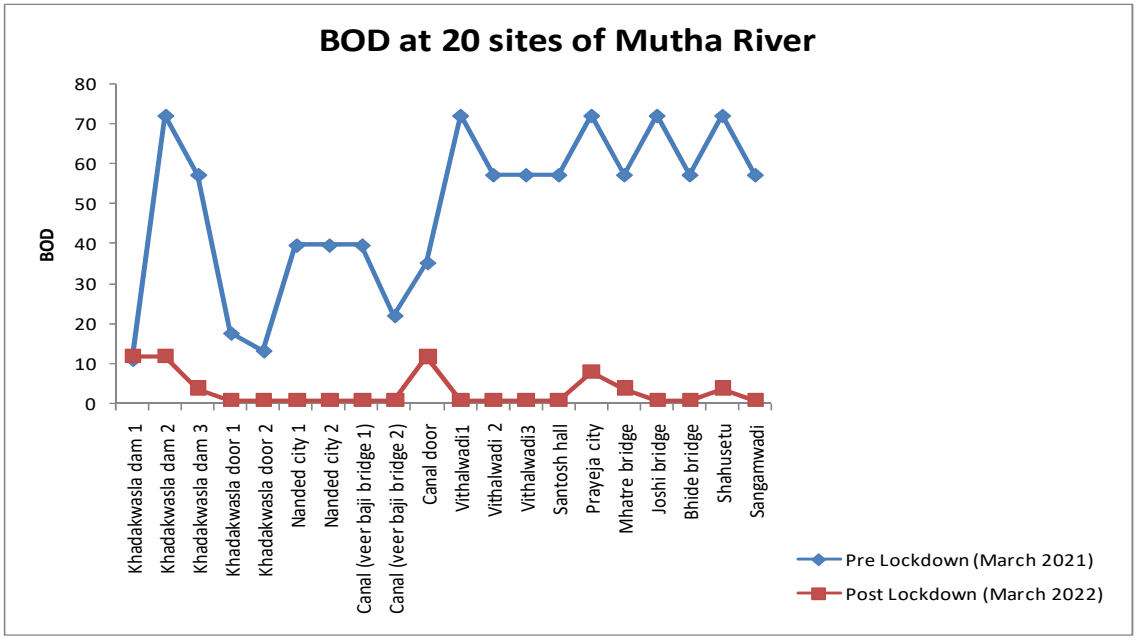

Fig 3 BOD at different sites of Mutha river

Statistical Analysis

The BOD and DO are measured for the samples collected on 20 sites (stations) before lockdown (March 2021) and after lockdown (March 2022) which are reported in Table 3. We assumed negative values of BOD as 1 since it can't be negative. A

statistical analysis is carried out in order to check statistically whether there is, on an average, a significant difference between before and after lockdown in BOD and for DO. The data is a paired dependent bivariate data in both the cases BOD and DO. Therefore, we apply paired t-test. The p-value from the paired t-test, in case of BOD, is found to be 4.47×10^{-09} which is less than level of significance (l. O. S.) denoted by $\alpha = 0.05$ and p-value, in case of DO, is found to be 5.4926×10^{-08} which is less than $\alpha = 0.05$. Hence, there is sufficient evidence to conclude that significant difference between before and after lockdown in DO and BOD.

DISCUSSION

A very important parameter of water quality is Dissolved Oxygen (DO). The values of DO observed across the 20 locations vary from 1.6 mg/L to 4.8 mg/L pre covid to 0 mg/l to 2.4mg/l post covid. This is an indication of high pollution. This may be the result of excessive algal growth due to high phosphorus content in river [11]. Another possibility is the decomposition of submerged plants which contributes to low DO [12]. As can be seen from the table above the BOD values show a wide range from 11 mg/L to 72 mg/L pre covid to -12 mg/l to 12 mg/l post covid. This reflects a very highly polluted state of the river pre covid from its start to its joining the Mula River. A high BOD signifies two things: -

1. There is a high number of microorganisms present in water, and

2. The high content of organic material in water is degraded by the micro organisms. This is an sign of organic pollution [6].

Increased BOD is a result of dumping of waste rich in phosphates and nitrogen compounds as these two-favour algal growth causing algal bloom and death of other underwater plants due to lack of sunlight. The decrease in BOD as can be seen during post covid period can be due to closure of different industries situated along the banks of river Mutha from its origin till the end. The occurrence of surplus organic matter favours the growth of microbes and decreases existing dissolved oxygen. The BOD is lowest at the source of the river during pre-covid and post covid times. As the river flows towards the city the value shows a slight increase probably the turbulence adding the settled organic matter into water. The samples from Khadakwasla dam show a sharp increase in BOD in pre covid samples. This is a result of the very high human activity in the dam water which ranges from dumping of domestic waste, left over foods, wash waters of the stalls lined along the dam to washing of animals by villagers from nearby villages. This is a nonstop activity in this area leading to pollution of dam water in recent times. But the values of post covid samples are low due to complete shutdown of places for humans. All human recreational activities, washing of animals and vehicles in the dam area was stopped during lock down and hence there was no addition of unwanted organic wastes keeping BOD values low. The samples collected at two locations near Nanded city show a very high BOD as compared to the previous ones. This is a result of the massive set ups and residential locations at Nanded city which apparently lead to pollution of river at this setting. The

BOD at three points beyond this is in the same range as the river banks have human settlements and small-scale industries which let off the waste in the river. In the post covid period the BOD shows a decrease perhaps due to decrease in activities. Also, as the eat outs and other such facilities in this area were completely closed hence a huge reduction in organic waste was observed. At the next location Vitthalwadi there is a further increase in BOD is observed in pre covid times. This is also a densely inhabited area. Adding to the human activities the temple at Vithalwadi attracts devotees in large numbers which definitely adds a big amount of organic waste to river. But with the covid lockdown temples were closed and also all the related activities, resulting in reduction of BOD. Prayeja city location shows the highest BOD in the path of the river. It's a true representative of extended urbanisation which is definitely stressing the existing city limits. Human intervention is leading to high BOD values. Small industries and workshops producing varied types of wastes lead to an increase in BOD. This could be due to addition of organic wastes or may be due to inhibition of the microorganisms which degrade the organic waste. Covid lock down seems to have helped in this situation too. Reduced human intervention, industrial activities and efficient garbage segregation methods followed by local government authorities resulted in decreased BOD. Beyond this the river enters Pune city showing high BOD. This increase is dangerous for the health of city population. This could also mean high numbers of microorganisms in the water which may be pathogenic leading to increase in water borne infections [12]. But during covid times all measures were taken to forbid addition of domestic waste into rivers and hence resulted in a decline of BOD value.

BOD signifies the amount of organic matter in a water supply. It rises when rotting plants, human or animal waste, and other biological carbon-based compounds are added to water. Some stain remover, using Sodium Percarbonate which in water is decomposed into sodium carbonate and hydrogen peroxide. The only evidence of this possibility is the increased oxygen compared to the initial reading. If enough sodium or potassium hydroxide is not added, if your measure of BOD is based on the difference of pressure between your initial and final reading, then the emission of carbon dioxide might explain an increase in pressure and so a negative value of BOD.

CONCLUSION

Growing water pollution is a foremost problem in all the rivers. Contaminated water is the chief health risk and threaten both, quality of life and public health equally. On our analysis on Mutha river we conclude following points:

1.The result and analysis clearly shows that Mutha river water quality has improved during covid lockdown.

2.It is clear from the present analysis that Mutha river showed lesser load of pollution owing to covid lock down. The proper collection and treatment of waste and regulation of the flow during lock down shows tremendous improvement in BOD values. Care should be taken by Local government bodies, Industry owners and people in general to maintain the health of river.

3.Public Awareness regarding river water pollution should be increased. Periodical examination of waste discharged by various industrial and domestic establishments should be carried out. Public entries and interference with water quality should be prohibited at riverbank.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

All the authors have made a substantial, direct and intellectual contribution to the work and approved it for publication.

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ETHICS STATEMENT

Not applicable

REFERENCE:

1. Fadtare V.V. and Mane, T. T. 2007. Studies on water pollution of mula, mutha and pawana rivers in summer season in the pune city region. Nature Environment and Pollution Technology., 6 (3) : 499- 506.
2. Chakraborty, B., Bera, B., and Adhikary, P.P. et al. 2021. Positive effects of COVID-19 lockdown on river water quality: evidence from River Damodar, India. Sci Rep: 11, 20140 https://doi.org/10.1038/s41598-021-99689-9
3. Joshi Y.. Rivers from Pune carry most polluted water: MPCB, Hindustan Times, Pune, 2017; Jun 29.
4. Khan, R., Saxena, A., Shukla, S. et al. 2021. Effect of COVID-19 lockdown on the water quality index of River Gomti, India, with potential hazard of faecal-oral transmission. Environ Sci Pollut Res 28, 33021–33029 https://doi.org/10.1007/s11356-021-13096-1
5. Abhyankar PS, Ambade SV and Patwardhan RB. 2002. Water pollution analysis of mutha river across pune city using bod as primary parameter**.** Pollution Research,; 39: 70-74.
6. Daoliang Li, and Shuangyin Liu, 2019. Detection of River Water Quality. Water Quality Monitoring and Management
7. Panos Seferlis. 2008. Measurement and process control for water and energy use in the food industry. Handbook of Water and Energy Management in Food Processing..

8. Dodds, K. W. and Whiles, M. R. 2020. Carbon,
9. Rodier J, Geoffray C. and Kovacsik G. Water Analysis. 2009Natural Waters, Residual Waters, Sea Water. Chemistry, Physico-Chemistry, Bacteriology, Biology. Dunod, Paris, France,.
10. APHA. Standard Methods For The Examination Of Water And Waste Water 22nd edn, Vol 3 113–118 (American Public Health Association, 2012).
11. Khsirsagar A.D. 2013. Diversity of Aquatic Fungi from Mula River at Pune City.. International Journal Advance Life Science.,; 6(3).
12. Jagtap S.S. and Manivanan R. 2019Water Pollution Status of Mula-Mutha Rivers in Pune City: Review. International Journal of Trend in Scientific Research and Development.; 4(1).