Study of Microbial and Physico-Chemical Parameters of Sea Water off Mumbai Coast During and After Monsoon.

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ABSTRACT *Mumbai is highly dependent on the sea for survival. Monitoring the parameters of water to safeguard the interests of the people who depend on it, is important. A comparative study of sea water quality off the coast of Mumbai, for the period of August-September 2017 (during monsoon) and December 2017-January 2018 (after monsoon) was done. Collection of sea water from Versova, Mumbai was done, and analysis of qualitative and quantitative tests such as TPC, pH, nitrogen content, BOD, COD were done, to relate to factors playing a role in the city such as monsoon, idol immersion, etc. The nitrite, nitrate ion, BOD and COD levels showed a drastic increase, but TPC showed decrease during winter season as compared to monsoon. pH remained at a range of 7.3-7.6. These results show that consumption of seafood during monsoon months should be avoided due to high microbial content.*

Keywords: *Sea water, Microbial study, Physicochemical study*

INTRODUCTION

Mumbai is a coastal city. The lifestyles of the mega-city, weather, food habits, etc. are all affected by the sea. It has a huge population of 12,442,373 (as per census 2011); and is still growing. A large fraction of people of Mumbai depend on the ocean for their livelihood, and others for its produce. The biodiversity of the marine life of Mumbai is vast, of which many are indigenous to our waters, including marine microbes. Diversity of these microbes depends on the physicochemical parameters of the water.

The Maharashtra Pollution Control Board (MPCB) recently determined that Mumbai's oceans are extremely polluted since the sewage discharge is unsupervised. According to a study by the local Municipal Corporation, about 2,200 to 2,400 MLD (million litres per day) of sewage is produced in the city, of which about 400-600 MLD reaches the ocean (Chatterjee, 2017). Such a huge amount of plastic and organic material creates an unbelievable amount of stress on the ocean, and the oxygen demand levels increase manifold. Factors like rising population and human interference create a steady increase of pollutants and pollution.

All these factors favour the growth of harmful bacteria. It causes the water to become toxic for the organisms living in it, and those consuming it. The growth and survival of microbes is interlinked with the chemical and physical properties of water.

During monsoons, the occurrence of diseases increases by a considerable margin. To prevent, or reduce these instances, their cause needs to be determined. Hence, it becomes essential to study the microbial and physicochemical properties of water. Microbial and physico-chemical aspects of the sea are greatly affected by natural and anthropogenic factors. While natural factors are not in our control, the anthropogenic activities that harm the sea can be reduced. Hence, it is of utmost importance that people first understand the kind of microbes that thrive in sea waters and also know their growth pattern with seasonal changes. Sea water assessment during winter was done in reference to temporal and spatial values by Kamble *et al.* (2010). Marine microbial quality assessment has been done by Kamble *et al.* (2011), Vignesh *et al.* (2014), Prema *et al.* (2017), at various coasts of India. Lelieveld *et al.* (2001) found that pollution levels were very high over Indian Ocean area caused by excess pollution originating from South and Southeast Asia. Shanmugam *et al.* (2006) carried out extensive research on marine pollution off the Chennai coast, and they concluded that open oceans are used for dumping of large masses of waste and are hence more vulnerable to damage. Rixen *et al.* (2014) studied the nitrogen cycle variations seasonally in the Arabian Sea. An extensive study on coastal water quality has been done by Srinivasan, Natesan and Parthasarathy (2013) on east and west coasts on India. They found low nutrient levels in mangroves of Bay of Bengal area during monsoon season, while Muthupet mangroves showed higher levels compared to Palk Strait.

RESEARCH MATERIALS AND METHODS

Ho_1: There is no difference in the Microbial Population of sea water between the time period of August-September 2017 (during monsoon) and December 2017-January 2018 (after monsoon).

Ho_2: There is no difference in the Physicochemical Parameters of sea water between the time period of August-September 2017 (during monsoon) and December 2017-January 2018 (after monsoon).

Collection of Sample

Collection of sea water sample took place at Versova for the two time periods of August-September 2017 (during monsoon) and December 2017-January 2018 (after monsoon). It also needs to be mentioned that there was an extended monsoon up to October in the year 2017 with frequent heavy showers.

Sea water was collected from Versova beach in clean and dry polythene containers, between 7-9am. Every test was conducted within 48 hours of collection of water sample to ensure that sample was not too old for analysis. A minimum of 5 samples were collected for each season.

Microbial study

Total plate count (TPC) was carried out on Zobell Marine agar by spread plate method, from samples incubated in Zobell Marine broth for 24 hours on rotary shaker. The microbial count of 10^{-4}, 10^{-5} and 10^{-6} serial dilutions was calculated. Isolation was carried out using the inverted "T" spreading technique on Zobell Marine agar. This plate was incubated for 24 hours at ~25°C and was then observed for the various colonies, and colony characteristics.

Physicochemical properties

i. pH

pH was tested using electronic pH meter in the lab. pH was tested within half an hour of sample collection.

ii. Nitrite-Nitrogen

Nitrite-nitrogen content in the samples was quantitatively measured colorimetrically at 540nm, after treatment with NEDD and sulphanilamide.

iii. Nitrate-Nitrogen

Quantitative analysis of Nitrate-nitrogen content was carried out colorimetrically, similar to nitrite-nitrogen. Nitrate ion analysis was carried out with same sample as nitrite at the same time. Sea water treated with Zn dust was used for Nitrate analysis.

iv. Biochemical Oxygen Demand

Dissolved oxygen content of sample water was carried out using Winkler's method. BOD was estimated using 5-day method.

v. Chemical Oxygen Demand

COD was estimated using titrimetric analysis, after treatment with N/80 $KMnO_4$, 9N H_2SO_4, potassium iodide powder, and titrated against N/80 $Na_2S_2O_3$ using starch indicator (1%).

OBSERVATIONS/RESULTS AND DISCUSSION

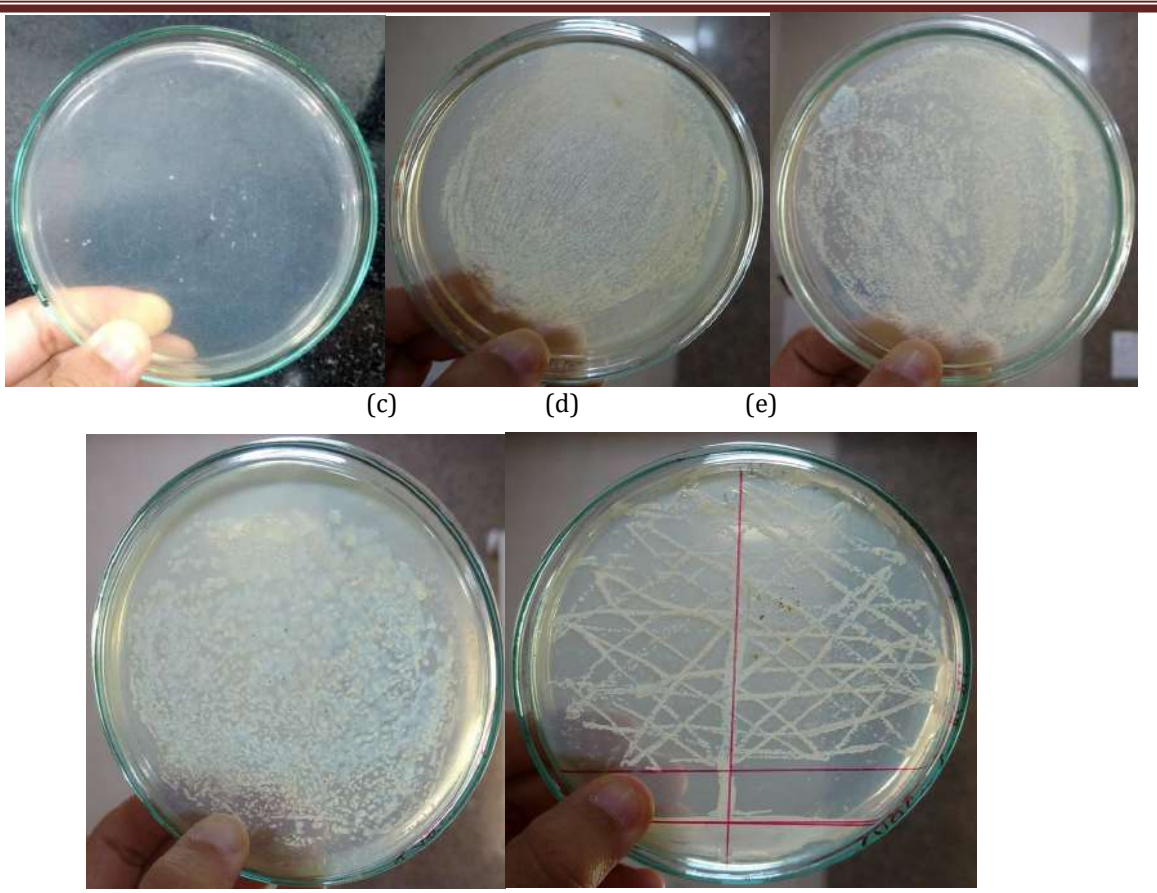
i. Microbial Study

Season	10^{-4} value	10^{-5} value	10^{-6} value
Monsoon	TNTC	19.5×10^6 CFU/mL	TLTC
Post-monsoon	TNTC	9.4×10^6 CFU/mL	TLTC

Table 1: Observations for TPC readings (*TNTC- Too numerous to count)

Microbial study was carried out using total plate count method with serial dilutions. Dilutions of 10^{-5} were used for purpose of research since it was in countable range. Colonies observed were mostly uniform, similar types with little difference in colony characters, apart from blue-green fluorescence observed during monsoon.

(a) (b)



(c) (d) (e)

(f) (g)

Fig 1: TPC microbial study- Pre-monsoon: (a) 10^{-4} dilution (b) 10^{-5} dilution (c) 10^{-6} dilution. Post-monsoon: (d) 10^{-4}(e) 10^{-5} (f) 10^{-6}. (g) T-plate isolation

ii. pH

Season	pH
Monsoon	7.2-7.4
Post-Monsoon	7.5-7.7

Table 2: Observation of pH levels

Analysis showed a fairly constant pH reading of slightly basic, between the two seasons, with slight fluctuations. The January 2018 reading for pH was seen to be higher, i.e. more basic as compared to September 2017 reading, however very marginally.

iii. Nitrite-Nitrogen and Nitrate-Nitrogen

Season	O.D. (540 nm)	Nitrite value	Nitrate value
Monsoon	0.06	75 µg atoms/L	12.5 µg atoms/L
Post-monsoon	0.05	90.90 µg atoms/L	18.19 µg atoms/L

Table 3: Observed readings of Nitrite and nitrate-nitrogen

Nitrite readings showed marked increase in value in the dry season of December 2017 - January 2018. This does not totally coincide with studies carried out by Palanisamy *et al,* who carried out studies in Chennai coastal waters and did not find much difference. However, Viswanathan *et al.* observed some difference between nitrite levels during monsoon and post monsoon, but showed slight increase in some stations under their study, along southeast coast of India.

Nitrate ion showed similar difference between monsoon and winter seasons, with winter showing marked increase from monsoons. However in both cases, levels of nitrate ions were observed to be significantly less than nitrite value.

Fig 2: Nitrate and nitrite-nitrogen readings. In order of Blank, Standard, Zinc treated, Zinc untreated.

iv. BOD

Season	Sample 1 (mg/L)	Sample 2(mg/L)	Sample 3(mg/L)
Monsoon	0.21	0.28	0.28
Post-Monsoon	0.91	0.91	0.88

Table 4: Readings of Biochemical Oxygen Demand

For monsoon season readings, samples were collected and analysed in the month of October 2017. For post monsoon, three consecutive days were chosen for analysis in the month of January 2018. Sample was not stored for more than 4 hours in each case. Marked difference was seen between the two seasons with a significant increase in the dry period.

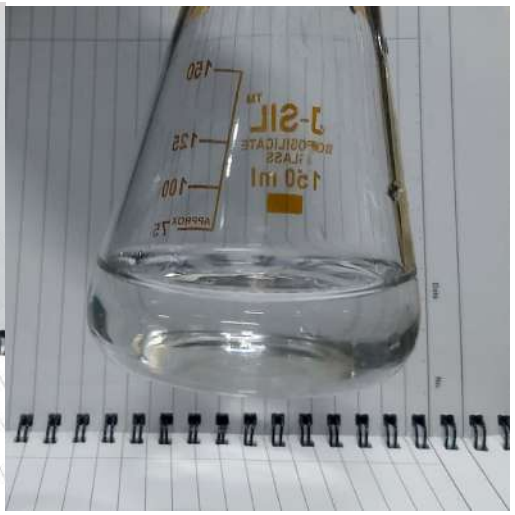


Fig 3: BOD reading pre-titration **Fig 4: BOD reading post-titration**

v. COD

Season	Sample 1 (mg of O_2/L)	Sample 2 (mg of O_2/L)	Sample 3 (mg of O_2/L)
Monsoon	39.7	43.4	43.6
Post-Monsoon	99	85.4	93.7

Table 5: Chemical oxygen demand observed readings

COD readings showed systematic increase between the two seasons and some fluctuation was seen in post-monsoon readings.

(a) (b) (c)

Fig 5: COD (a) Pre-titration (b) During titration (c) Post-titration

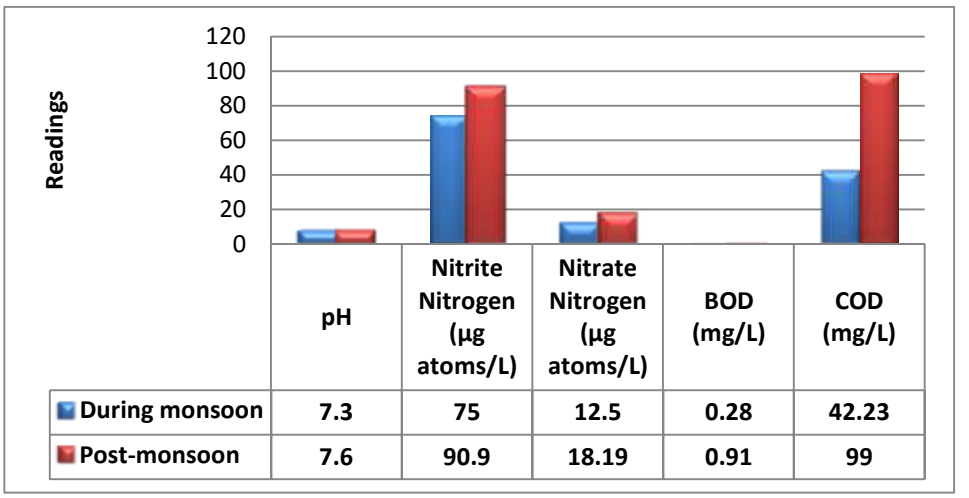
INTERPRETATION OF RESULTS

A drastic difference is seen between the readings of Monsoon and Post-monsoon. All parameters, except the microbial studies, showed an increase in the readings in winter season as compared to monsoon season. The higher microbial count could explain the higher number of incidences of water borne diseases during the monsoon months.

The number of viable, colony forming organisms shows a marked increase during the monsoon months of August-September 2017. This range is slightly higher, as compared to the studies carried out by Upadhyay *et al.,* who carried out microbial study along the waters of the west coast of India, and Kamble *et al.* who studied water quality in western coastal regions. However, the difference in values for during monsoon, and post monsoon seem to be consistent in both the cases.

Apart from the number of microbes, samples collected during monsoon 2017 also showed more variety, as compared to January 2018, which displayed fewer types of microorganisms. Monsoon period also showed a huge variety of organisms which exhibited fluorescence, as compared to the winter period.

The difference in the level of the physiochemical and microbial parameters can be explained on the basis of the different weather conditions. It could also be affected by anthropogenic activities. One of the most prominent festivals in Mumbai, Ganesh festival, occurs during the monsoon period. It involves immersion of a large number of plaster of Paris idols in the sea, specifically along the coast of Versova and Juhu beach. These idols also, often, are made up of harmful paints. These substances, when immersed in the sea water, could change the various physiochemical and microbial parameters. Mud idols, although ecologically friendly, cause a build-up of silt on the ocean floor, leading to favourable growth conditions, and increase in nutrient and oxygen demand. Basicity of sea water is usually unexpected as sea water is usually slightly acidic, but the above-mentioned activities might have increased the pH of the water; the collection points mainly being the areas of idol immersion.



	pH	Nitrite Nitrogen (µg atoms/L)	Nitrate Nitrogen (µg atoms/L)	BOD (mg/L)	COD (mg/L)
During monsoon	7.3	75	12.5	0.28	42.23
Post-monsoon	7.6	90.9	18.19	0.91	99

Fig. 6: Comparative tabulation of data during and post-monsoons

CONCLUSION

Mumbai's strong coastal connection calls for a thorough examination of our produces on the sea. Many families refuse to consume fish caught during the months of August-September in Mumbai due to the factors such as monsoons and Ganesh festival. The study shows that the drastic increase in microbial population during monsoon season appears to validate the fears of the common people. The increase in physicochemical properties seems to stagger microbial growth, especially nitrate and nitrite levels. Variation in the number of colonies of pathogenic organisms make it possible to relate to a larger number of cases of water-borne diseases. It is evident that the sea plays a role in this, as has been analysed. An awareness of the state of our sea water would be created through this study, and hopefully bring about a change in behaviour towards it. The study would also help overcome health problems especially related to waterborne microbes.

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When you can't change the direction of the wind — adjust your sails.

~ H. Jackson Brown