# The effect of Phytoplankton on the water quality of Daha River in Siwan and it's Impact on Near-by Localities

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## Abstract

Phytoplanktons play pivotal role in deciding water quality. The presence of various algae impairs the taste and odor of water. Algae consume a number of elements from water during their growth. Their excessive growth increases BOD, increased acidity and high pH. The industrial effluents are rich in nitrates and phosphates which promote the growth of phytoplankton. The present study focuses on the impact of phytoplankton and pollution on the taste and quality of water of Daha river in Siwan, Bihar. The water quality was investigated for a period of six months from January 2021 to June 2021. The surface water samples were collected monthwise, from three sites of the River Daha. The physio-chemical parameters analyzed were temperature, pH, acidity, alkalinity, BOD, COD and their co-relations with the phytoplankton and nearby water of the River. The species of phytoplankton identified belonged to class chlorophyta, Bacillariophyta (diatoms) and Cyanophyta. Diatoms were found to be present at all the three sites. The Study revealed that the presence of Oscillatoria, Euglina, Volvox (fishy odor), Staurastrum (grassy odor) detoriated the quality and odor of the water of Daha river. The analysis of physio-chemical parameters indicated that the water quality of Daha river and nearby places were deteriorated by the industrial effluents and human interventions.

**Keywords:-** Phytoplankton, Interventions, BOD, COD, Fishy Odor, Physio-chemical.

**DOI Number: 10.14704/nq.2022.20.13.NQ88250** **Neuro Quantology 2022; 20(13):2008-2013**

## Introduction

Phytoplankton refers to the microscopic form of living plants that have little or no resistance to currents and are free floating or suspended in water bodies. Many of them are photosynthetic and are grazed upon by zooplanktons. They are largely Algae.

The quick response of Phytoplankton towards the changes in their environment can be attributed to their short life cycle. And hence their standing crop and species compositions are more likely to indicate the quality of water body, in which they are found. They strongly influence water quality such as odor, taste, colour and even the pH of that water.

The quality of drinking water is an important factor in determining human wellness. We know that polluted drinking water is the cause of water born diseases which have been reported to wipe out the entire population of that area, in some cases. The major sources of water pollution are the domestic wastes, industrial wastes (which are directly discharged into these water bodies), the toxins and secondary metabolites produced by the algae in the said Daha River flowing through Siwan district. The toxins produced by the algae causes diarrhea, nausea or vomiting, skin, eye or throat irritation. It may cause allergic reactions and breathing difficulties. The exposure can also cause electrolytic imbalance, headache, muscle weakness or pain in joints and limbs.

## Materials and Methods

The present study was conducted in River Daha, in Siwan at three sites namely

1. Mahadewa – VMHE ($S_1$)
2. Naya quila ($S_2$)
3. Shri nagar ($S_3$)

It lies in between 25$^0$22' N to 26$^0$22' N latitude and 84$^0$ E to 84$^0$47' E longitude. It has got a length of 85 Kms from east to west and width of 52 Kms from north to south. The water samples were collected monthly from these selected sites for a period of six month from January to June 2021.

The temperature and pH of water samples were noted by standard methods on the spot at the time of sample collection. The water to determine the dissolved oxygen (DO), was collected and fixed on the spots. The physio-chemical parameters like acidity, alkalinity, biological oxygen demand (BOD) and chemical oxygen demand (COD) were analyzed by standard method (APHA-1998).

Almost a liter of water samples were collected for phytoplankton analysis and were preserved immediately in 4% formalin solution and brought to the laboratory. The samples were concentrated to 60 ml and thereafter the number of phytoplanktons per liter was counted by Sedgwick Rafter cell method. The data obtained were analyzed as pre-monsoon, monsoon and post-monsoon phase wise.



**Results and Discussions.**

The study highlights that the water quality parameters fluctuated with sites and seasons as represented in Table 1. The growth and reproduction of phytoplankton are affected by various physio-chemical parameters of water (APHA-1998). The analysis of physio-chemical parameters of water reveals that the water of Daha River showes deterioration with the fluctuation of seasons: pre-monsoon (Fig 1), monsoon (Fig 2) and post-monsoon (Fig 3). The pollution level was severe in pre-monsoon season that is from February to May. The pollution level gets minimized in June due to rainfall and plenty of water (Table 1).

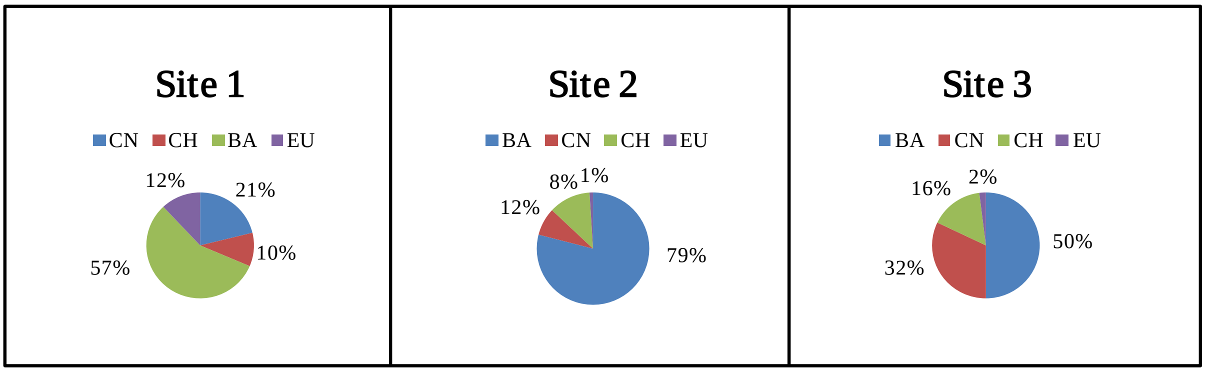


Fig 1. Seasonal analysis of phytoplankton during Pre-monsoon

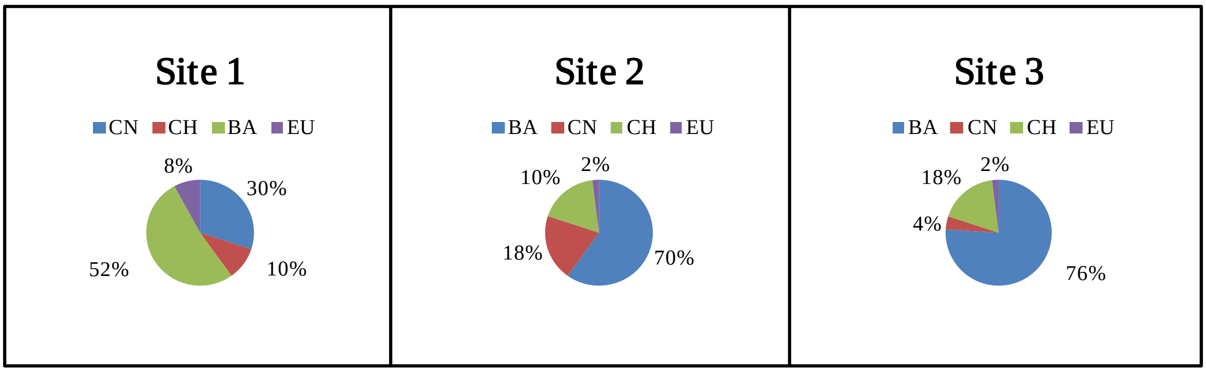


Fig 2. Seasonal analysis of phytoplankton during monsoon

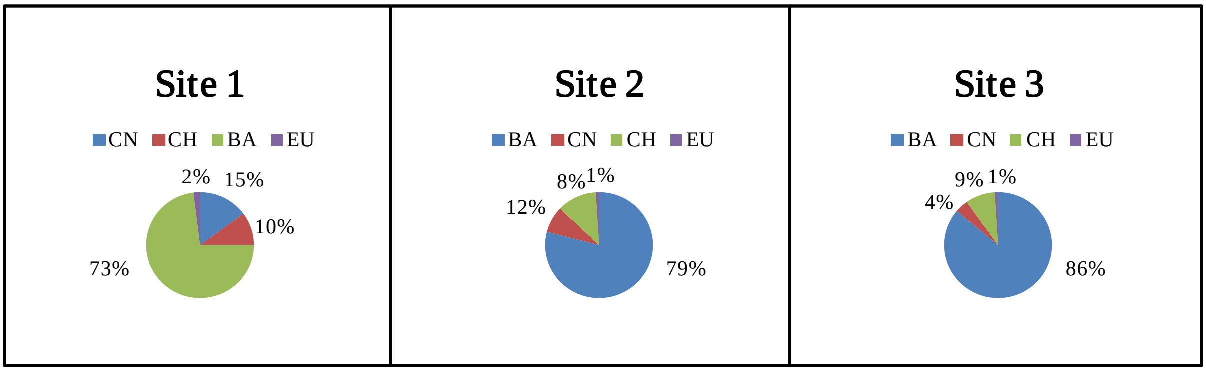


Fig 3. Seasonal analysis of phytoplankton during Post-monsoon

As we know that temperature is one of the important factors responsible for the growth and reproduction of phytoplankton, as it enhances the rate of chemical reactions, reduces the solubility of gases and hence affects the taste and odor of water. Temperature also affects the pH, conductivity and alkalinity of water (Trivedy et al. 1998). These factors influence the rate of decomposition of organic matters by micro-organisms.

The other component, nitrates, is an important nutrient for the growth of phytoplankton, especially algae. The nitrate levels ranging from 0 mg/l to 40.23 mg/l were observed due to eutrophication.

The presence of high concentration of phosphate ions in water accelerates plant growth. In the present study the phosphate ions concentration was found in the range of 0.032 mg/l to 0.129 mg/l.

**Table.1** Seasonal fluctuations of physico-chemical parameters in Daha River

| Sl. No: | Parameters | Site No: | Pre- Mon | Mon | Post Mon | MIN | MAX | MEAN | SD |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Temperature °C | 1 | 12.3 | 11.6 | 12.4 | 11.6 | 12.4 | 12.10 | 0.13 |
| | | 2 | 13.2 | 12.5 | 13.2 | 12.5 | 13.2 | 12.96 | 0.33 |
| | | 3 | 16.5 | 19.8 | 28.6 | 16.5 | 28.6 | 21.63 | 6.25 |
| 2 | pH | 1 | 7.3 | 8.0 | 7.8 | 7.3 | 8.0 | 7.70 | 0.36 |
| | | 2 | 7.2 | 7.6 | 7.4 | 7.2 | 7.6 | 7.40 | 0.20 |
| | | 3 | 7.8 | 8.5 | 8.2 | 7.8 | 8.5 | 8.16 | 0.35 |
| 3 | Acidity mg/L | 1 | 8.5 | 5.0 | 5.4 | 5.0 | 8.0 | 6.13 | 1.62 |
| | | 2 | 10 | 6.0 | 7.0 | 6.0 | 10 | 7.66 | 2.08 |
| | | 3 | 5.4 | 4.1 | 4.5 | 4.1 | 5.4 | 4.66 | 0.66 |
| 4 | Alkalinity mg/L | 1 | 64 | 72.00 | 22 | 22 | 64 | 52.67 | 26.85 |
| | | 2 | 64 | 54.50 | 46 | 46 | 64 | 54.83 | 9 |
| | | 3 | 54 | 43.00 | 48 | 43 | 54 | 48.33 | 5.50 |
| 5 | Calcium mg/L | 1 | 50.2 | 42.0 | 48.2 | 42.0 | 50.2 | 46.80 | 4.27 |
| | | 2 | 51.6 | 45.2 | 46.0 | 45.2 | 51.6 | 47.8 | 3.36 |
| | | 3 | 50.1 | 46.3 | 48.2 | 46.3 | 50.1 | 48.20 | 1.9 |
| 6 | Magnesium | 1 | 12.8 | 10.6 | 14.4 | 10.6 | 14.4 | 12.60 | 1.91 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | mg/L | 2 | 17.6 | 14.3 | 14.8 | 14.3 | 17.6 | 15.56 | 1.77 |
| | | 3 | 15.3 | 13.6 | 14.6 | 13.6 | 15.3 | 14.5 | 0.85 |
| 7 | Chloride mg/L | 1 | 8.10 | 8.6 | 6.25 | 6.25 | 8.60 | 7.65 | 1.23 |
| | | 2 | 8.8 | 6.8 | 5.93 | 5.93 | 8.8 | 7.17 | 1.47 |
| | | 3 | 7.3 | 6.6 | 6.00 | 6.00 | 7.3 | 6.63 | 0.65 |
| 8 | Salinity ppt | 1 | 9.38 | 8.89 | 0.34 | 0.34 | 9.38 | 6.20 | 5.08 |
| | | 2 | 11.63 | 10.17 | 0.22 | 0.22 | 11.63 | 7.34 | 6.20 |
| | | 3 | 10.77 | 9.07 | 0.27 | 0.27 | 10.77 | 6.70 | 5.63 |
| 9 | Nitrate mg/L | 1 | 1.25 | 0.90 | 0.191 | 0.90 | 1.25 | 0.78 | 0.53 |
| | | 2 | 0.234 | 0.19 | 0.275 | 0.19 | 0.275 | 0.23 | 0.04 |
| | | 3 | 0.385 | 0.034 | 0.225 | 0.034 | 0.385 | 0.21 | 0.17 |
| 10 | phosphate mg/L | 1 | 0.60 | 0.129 | 0.022 | 0.022 | 0.60 | 0.25 | 0.30 |
| | | 2 | 0.035 | 0.059 | 0.058 | 0.035 | 0.059 | 0.5 | 0.01 |
| | | 3 | 0.032 | 0.058 | 0.052 | 0.032 | 0.058 | 0.22 | 0.31 |
| 11 | DO mg/L | 1 | 3.10 | 5.60 | 4.25 | 3.10 | 5.60 | 4.31 | 1.25 |
| | | 2 | 6.8 | 7.8 | 6.15 | 6.15 | 7.8 | 6.91 | 0.83 |
| | | 3 | 6.7 | 7.6 | 7.5 | 6.7 | 7.6 | 7.26 | 0.49 |
| 12 | COD mg/L | 1 | 110 | 116 | 120 | 110 | 120 | 115.33 | 5.03 |
| | | 2 | 135 | 125 | 25.5 | 25.5 | 135 | 95.16 | 60.53 |
| | | 3 | 112 | 136 | 39.0 | 39.0 | 136 | 95.67 | 50.52 |
| 13 | BOD mg/L | 1 | 0.06 | 0.02 | 0.09 | 0.02 | 0.09 | 0.05 | 0.03 |
| | | 2 | 0.043 | 0.021 | 0.040 | 0.021 | 0.043 | 0.03 | 0.01 |
| | | 3 | 0.03 | 0.05 | 0.07 | 0.03 | 0.07 | 0.5 | 0.02 |

Biological oxygen demand (BOD) determines the level of organic pollution in the river water. The permissible limit of BOD for natural water is 3 mg/l or less. But in current study, BOD ranged from 0.02 mg/l to 0.09 mg/l. It can be attributed to the enhansed population of phytoplanktons.

Chemical oxygen demand (COD) is the amount of oxygen required to chemically oxidize the organic material and inorganic nutrients like nitrates, phosphates and ammonia. COD indicates the discharge of waste water into the water body (Prasmody et al 2019). COD of surface water ranges from 5 mg/l to 20 mg/l. In present study the COD value ranged from 25.5 mg/l to 136 mg/l. The high value of COD indicates the presence of non-biodegradable oxygen demanding pollutants in the water.

Dissolved oxygen (DO) is an important parameter to determine the water quality. Oxygen is essential for the metabolism of all aquatic organisms thriving on aerobic respiration (Wetzel 1975). Dumping of oxygen demanding materials, either organic or inorganic into the river, causes depletion of DO. This poses threat to the phytoplankton and other aquatic organisms. In our study, DO of the river ranged from 3.1 mg/l to 7.8 mg/l, whereas, the normal level of DO ranges from 6.5 mg/l to 8mg/l. Low level of oxygen indicate excess of organic material due to decomposition of algal blooms by micro-organisms.

In present study, we identified 49 species of phytoplankton, those belonged to 28 genera of four taxonomic divisions which are Cyanophyta, Bacillariophyta, Chlorophyta and Euglenophyta from selected sites of the river Daha in Siwan district. Out of 49 algae species 12 belonged to Cyanophyta, 7 to Chlorophyceae, 30 species belonged to Bacillariophyceae and 2 species belonged to Euglenophyceae as indicated in Table-2.

**Table.2** Phytoplankton diversity in Daha River

| Sl. No | Algal class | No: of genera | No: of species | % |
|---|---|---|---|---|
| 1 | Cyanophyceae | 6 | 12 | 21.4 |
| 2 | Chlorophyceae | 4 | 7 | 13.2 |
| 3 | Bacillariophyceae | 18 | 30 | 62.2 |
| 4 | Euglenophyceae | 1 | 2 | 3.2 |
| **Total** | | **29** | **57** | **-** |

The number of phytoplankton was very less at all the sites during the month of January and February. The parentage of bacillariophyceae was more as compared to chlorophyceae or cyanophyceae in the pre-monsoon period. The percentage of bacillariophyceae during the study period, was more due to their high ecological amplitude in reverine water. The fluctuations in the percentage of other phytoplankton were also observed. It is represented through Fig- 4.

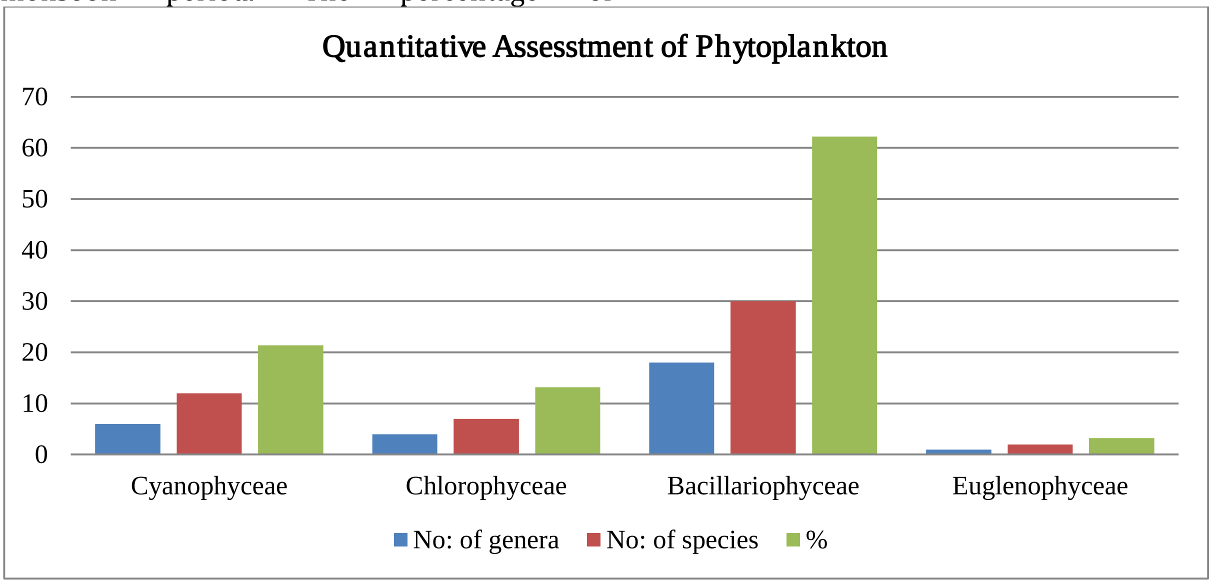


Fig 4. Seasonal analysis of phytoplankton during monsoon

Earlier reports suggest that a number of algal genera have species that grows well in high concentration of organic wastes, such as-chlamydomonas, volvox, oscillatoria, blue green algae staurastrum, anabena. These were also identified at different sites of the Daha River.

❖ Algae are known to affect the taste and odors of river water. In fact, a large number of algae are associated with taste and odors. Certain algae like volvox, gives water a fishy odor. Blooms of staurastrum gives grassy odor. Anabaena is a blue green algae that helps in nitrogen fixation. It produces chemicals like antitoxin and microcystin which are toxic and causes gastro-intestinal and liver disorders.

❖ The Phytoplankton responds quickly to the environmental changes and hence the species composition of phytoplankton indicates the water quality (APHA-1998). Algae are frequently found in polluted as well as unpolluted water and hence are generally considered useful in determining the quality of water. Thus they are indicator of water pollution of different water bodies (Trivedy 1986, Sudhatea et al 1994). Combined with previous reports, the data collected by us, it is concluded that all the three sites were polluted and the physio-chemical parameters very closely influence the phytoplankton growth and development.

## Conclusion:-

The present study revealed that the selected three sites of Daha River were polluted due to human interventions. The effect of phytoplankton on the quality, odor, taste of water and different gastro-intestinal diseases around the localities of this river were also profound. The level of pollution were severe during pre-monsoon and post monsoon seasons. The unwanted and high concentrations of organic and inorganic wastes were washed away during monsoon season.

As far pH, total hardness, COD, DO and B.O.D. is concerned, they were not found to be within the permissible limits.

## Acknowledgement :-

Authors would like to thank for Infrastructure support received from Botany Department, D.A.V. P.G. College, Siwan.

## Author Contributions:-

GM carried out the sample collection and experiments and participated in writing of the manuscript. AS conceptualized the study and participated in the preparation of the manuscript. Both authors have read and approved the final manuscript.

## Competing financial interests

The authors declare no competing financial interests.



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