Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 24s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Studies On Drinking Water Treatment Plants Concerning Water Quality and Algal Growth - A Case Study

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Cite this paper as: Priyadarshani Patil, Prajkta Sarkale, Aparna Pathade, Girish Pathade, (2025) Studies On Drinking Water Treatment Plants Concerning Water Quality and Algal Growth - A Case Study. *Journal of Neonatal Surgery*, 14 (24s), 923-926

ABSTRACT

Potable water is free from harmful microorganisms and chemicals, but it must also be free from turbidity, taste, odor, and color. Natural waters contain nutrients for organism growth, including algae. Tastes and odors are complex and can cause problems in water treatment. Polluted water can carry pathogenic organisms, leading to communicable diseases. If treatment plants aren't maintained, biological growth from algae, bacteria, and fungi can infest tanks and equipment, leading to issues like tastes, odors, slime production, filter clogging, and discoloration. Water samples from various units were analysed with references to APHA (1996), detecting coliform bacteria.

Algal identification was made using standard texts and monographs. In the present study treatment plant, which draws its water from the River Koyna (Karad, Maharashtra, India), was studied. However, nuisance algae, can cause health problems by making water unpalatable and affecting water purification and distribution. The most dominant algae are Oscillatoria and Gyrosigma, while Fragilaria, Meosira, Synedra, Nitzschia, Navicula, and Spirogyra are common filter and screen clogging algae. Excessive algal growth in the plant may require frequent cleaning of rapid sand filters. Studies on Drinking Water treatment plant concerning water quality and algal growth have highlighted the complexities of treating water impacted by harmful algal blooms. The integration of real-time monitoring systems, improved source water protection, and climate adaptation strategies is vital for ensuring the safe supply of drinking water in the face of increasing algal threats

1. INTRODUCTION

A key component in ensuring the availability of safe water to consume free of contaminants and harmful microbes is drinking water treatment. While they are not always directly hazardous, bacteria, algae, and various other microorganisms that frequently occur in natural water sources may compromise the water's safety and quality. In particular, the development of algae offers serious challenges for water treatment frameworks, impacting their performance, taste, and odor. Based on recent studies, enriching nutrients and environmental changes have become algae prevalent, leading to the need for effective treatment methods.

Potable water is defined as water free from pathogenic microorganisms and harmful chemicals, along with acceptable taste, odor, and color. Natural waters, often used as sources for drinking water, contain nutrients that can support the growth of microorganisms, including algae. Certain algae and other microorganisms can impart taste and odor, produce slime, clog filters, and discolor water, affecting the efficiency of treatment plants (Palmer, 1980). Surface and groundwater sources polluted by fecal matter pose significant risks of diseases like typhoid, cholera, hepatitis, and polio. Proper treatment steps—pretreatment, coagulation, flocculation, filtration, and disinfection—are essential to remove impurities and pathogens. Neglected maintenance of treatment facilities can lead to biological infestations, resulting in operational issues and compromised water quality.

Because of nutrient loading, global warming, and rising carbon dioxide levels, algal blooms in source waters have gotten worse. Toxins and organic matter are introduced by these blooms, making water treatment more difficult. Algae that produce disagreeable tastes and odors, clog filters, and interfere with disinfection procedures include Oscillatoria, Melosira, and Fragilaria. Research from Egypt showed that, depending on the species and operating conditions, treatment facilities using sedimentation and fast sand filtration could eliminate up to 100% of algae. Variations in the abundance and composition of algal species, however, underscore the necessity of adaptive treatment strategies (Faith et al., 2021).

The application of chemical oxidants and sophisticated coagulants has drawn interest as a means of reducing algal problems. Although there are still difficulties in treating mixed algal communities, research conducted in Australia indicates that .

targeted oxidants efficiently inhibit cyanobacteria and degrade organic matter. Additionally, combining physical and biological monitoring—such as algal counts—helps optimize treatment procedures and guarantees adherence to safety regulations (Abouzied et al., 2022).

The Malkapur plant case study illustrates typical challenges faced by modern facilities. Although the plant initially reported minimal algal growth, early signs of taxa like *Oscillatoria* and *Fragilaria* emphasize the importance of proactive cleaning and maintenance to prevent large-scale infestations. As global trends indicate rising algal risks, adopting cutting-edge monitoring and treatment technologies will be crucial for plants like Malkapur to sustain water quality and operational efficiency.

This study evaluates the performance of a relatively new drinking water treatment plant in Malkapur (Karad) with regard to water quality improvement and initial signs of algal growth

2. MATERIALS AND METHOD

Water sampling: Water samples were collected from key points of the plant, including the raw water entry point, clarification tank, filtration tank, and post-disinfection outlet. Samples was taken to the laboratory using Ice packs and maintained at 4℃ till further analysis.

Algal sampling: Collected algae samples using plankton nets (mesh size 50 µm). samples were fixed immediately with Lugol’s iodine solution for preservation.

Physico-chemical analysis

Collected water samples were analysed for:

pH: measured with a digital pH meter; Dissolved Oxygen (DO): Measured using the Winkler method (APHA); Chlorides and Hardness: Titrate against silver nitrate and EDTA, respectively; TDS (Total Dissolved Solids): measured using TDS meter; Conductivity: Measured using a conductivity meter.

Microbiological analysis: Detection of coli form bacteria were done using Most probable number technique with Brilliant Green Lactose Bile broath (APHA, 1996).

Identification of algae: The algal identification was made by using standard texts and monographs (Desikachary 1959, Prescott 1951, Randhawa 1959, Sarode & Kamat 1984).

Interpretation of results were done according to BIS standards IS of Drinking water 10500.

3. RESULT AND DISCUSSION:

The quality of raw water usually present in nature is not suitable for drinking due to presence of diverse types of impurities present both in dissolved and suspended form. Besides, microorganisms of pathogenic nature may also be present in the natural waters, which along with other impurities, have to be removed during the treatment of water before the water could be supplied to people. The treatment plant draws its raw water from the River Koyna.

The pH of the water was found to be neutral in the raw water, which remained unchanged up to the final step of treatment. The dissolved oxygen was 7.4 mg/L in raw water, but during treatment it ranged from 6.0 to 6.6 mg/L. Chloride was 17.04 mg/L in water but later has fallen to 15.62 mg/L during the treatment. Hardness showed values between 72 mg/L and 75 mg/L, having not much difference. TDS varies from 79.95 to 86.45 mg/L. The raw water has the presence of coliforms, which could not be removed up to the step of filtration, but fully removed in the process of disinfection by chlorination During treatment, the coliform bacteria and other contaminants found in the raw water from the River Koyna had been effectively eliminated. During the entire treatment process, the water's pH stayed neutral. During clarification and filtration, dissolved oxygen (DO) slightly dropped but stayed within tolerable bounds. Hardness and total dissolved solids (TDS) were well within BIS standards, while chloride levels slightly decreased (Table 1). The raw water's coliforms remained until the filtration stage, but they were completely eradicated following chlorination, indicating that the disinfection process was successful.

Water Quality Parameters

The raw water sourced from the River Koyna contained various impurities and coliform bacteria, which were effectively removed during treatment. The pH of the water remained neutral throughout the treatment process. Dissolved oxygen (DO) decreased slightly during clarification and filtration but remained within acceptable levels. Chloride levels reduced marginally, and hardness and total dissolved solids (TDS) were well within BIS standards (Table 1).

The coliforms present in the raw water persisted until the filtration stage but were entirely eliminated after chlorination, demonstrating effective disinfection.

Table 1: Physico-chemical quality of raw water and treated water along with BIS standards

Parameter	**Raw Water**	**Clarification**	**Filtration Tank**	**After Disinfection**	**BIS Standards**	**Quality of Water**
pH	7	7	7	7	7.0-8.5	Acceptable
Dissolved Oxygen (mg/L)	7.4	6.0	6.4	6.6	-	-
Chloride (mg/L)	17.04	15.62	15.62	15.62	200	Acceptable
Hardness (mg/L)	75	73	72	72	200	Acceptable
TDS (mg/L)	79.95	84.5	81.25	86.45	500	Acceptable
Coliforms	Present	Present	Present	Absent	0	Acceptable

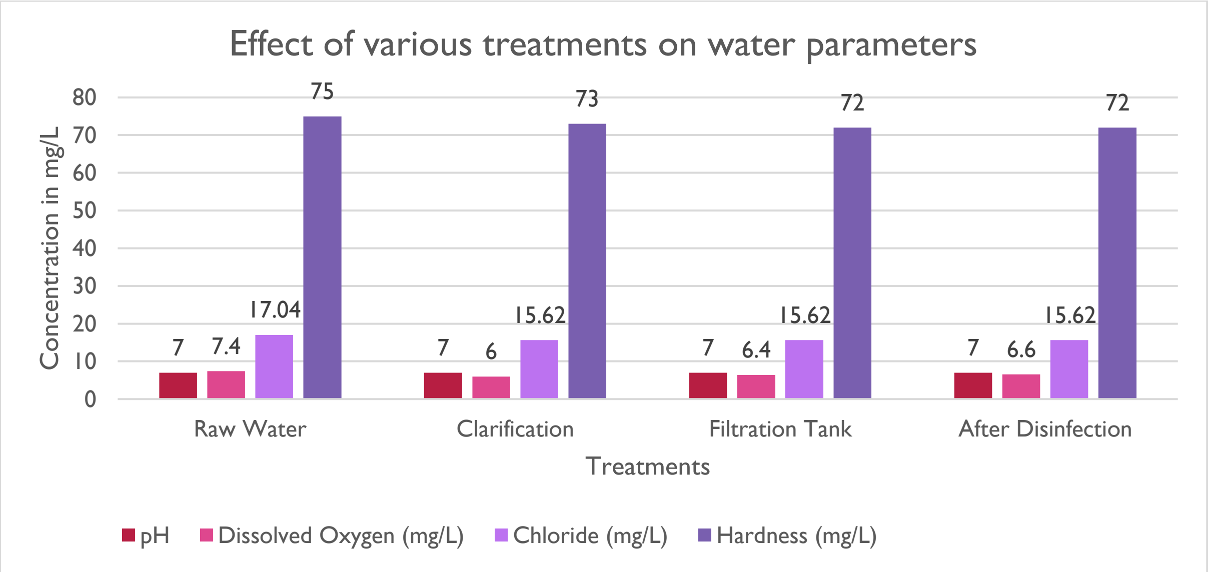

Figure 1 Effect of various treatments on parameter of water

Algal Growth in the Treatment Plant

Algal growth, though limited due to the plant's newness, was observed, particularly in the clarification tank. Identified taxa included *Amphora*, *Oscillatoria*, *Gyrosigma*, *Fragilaria*, *Melosira*, *Synedra*, and *Spirogyra*, among others (Table 2). *Oscillatoria* and *Gyrosigma* were the dominant species.

- *Oscillatoria* contributes to slime production and discoloration of water.
- Species like *Fragilaria*, *Melosira*, *Synedra*, *Nitzschia*, and *Spirogyra* are known for clogging filters and screens (Palmer, 1980).

Unchecked algal proliferation can obstruct treatment processes, necessitating frequent filter cleaning and increasing maintenance costs.

Table 2: Algal species identified and their significance

Sr. No.	Name of Algae	Abundance	Comments
1	*Amphora* sp.	Medium	-
2	*Oscillatoria* sp.	High	Slime producing & color causing
3	*Gyrosigma* sp.	High	-
4	*Hylotheca* sp.	Low	-
5	*Fragilaria* sp.	Medium	Filter & screen clogging
6	*Caloneis* sp.	Medium	-
7	*Pediastrum simplex*	Low	-
8	*Melosira* sp.	Low	Filter & screen clogging
9	*Synedra* sp.	Low	Filter & screen clogging
10	*Staurastrum paradoxum*	Low	-
11	*Nitzschia* sp.	Low	Filter & screen clogging
12	*Navicula* sp.	Low	Filter & screen clogging
13	*Spirogyra* sp.	Low	Filter & screen clogging

4. CONCLUSION

The water treatment plant effectively improves the physical, chemical, and microbiological quality of water to meet BIS standards. While the current algal growth is minimal, its presence highlights the need for routine cleaning and maintenance to prevent operational challenges. Early intervention is crucial to managing algal growth and ensuring the sustained efficiency of the treatment plant.

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