COMPREHENSIVE CHARACTERIZATION OF MUNCIPAL SEWAGE WATER: COMPOSITION, CONTAMINANTS, AND CHALLENGES

ABSTRACT

The present study was carried out on characterization of municipal sewage water tank of Manchalapur village near Raichur city in Karnataka. The water samples were collected from inlet, outlet and water spreading area of the Manchalapur tank during the year 2018-2019 in monsoon and post monsoon season. The collected water samples were analyzed for the water quality parameters like pH, EC, TDS, carbonate, bicarbonate, nitrate, phosphate, calcium, magnesium, sodium, BOD, COD, DO and turbidity by using standard methods. The results obtained were compared withinirrigation water quality standards. The results showed that pH (ranges from 7.36-8.54) of surface water and ground water were slightly alkaline in nature. The EC and TDS of surface water and ground water were not within the drinking water quality standards. The results obtained for monsoon season, the mean value of BOD (562.31, 977 mg L^{-1}), COD (15270.44, 11138.63 mg L^{-1}), DO (7.72, 7.70 mg L^{-1}) and turbidity (11.20, 11.37 NTU) for surface water and ground water respectively. Similarly result obtained for post monsoon, the mean value of BOD (457.88, 904 mg L^{-1}), COD (7189.69, 9287.38 mg L^{-1}), DO (4.97, 4.93 mg L^{-1}) and turbidity (11.37, 11.20 mg L^{-1}) for surface water and ground water respectively. All the water quality parameters were within the recommended range of irrigation standards except the parameters BOD, COD, DO and turbidity.

Keywords: Muncipal sewage, irrigation, water samples, monsoon, post monsoon.

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1. INTRODUCTION

Water is essential for all human activities and this is facing increasing strain due to growing populations demanding high-quality water for both domestic and economic needs. Better management of freshwater quality is a top environmental priority in India this century, with surface water sources experiencing heightened pressure due to population growth. Tank irrigation, an ancient practice in India, is particularly significant in the southern parts of the country, where average annual rainfall is around 700 mm. There are about 127,000 tanks in the southern region consisting of Andhra Pradesh, Tamil Nadu and Karnataka states [3].

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Approximately 20 million hectares of agricultural land worldwide are irrigated with treated or untreated wastewater, with a growing necessity for its use in developing countries. Factors driving this expansion include rising water stress, urbanization, increasing urban wastewater flows, and more urban households participating in agricultural activities that could benefit from additional irrigation water sources [4].

The increasing reliance on agricultural wastewater confronts a significant obstacle due to its reliance on either untreated wastewater or polluted waters from rivers and streams. Limited availability and high costs of freshwater, coupled with inadequate wastewater treatment infrastructure to accommodate urban growth, leave urban farmers with little choice but to use highly contaminated water for their agricultural needs. This situation poses a particularly difficult challenge for the urban poor, who depend on agriculture for income, employment, and food security, highlighting the complex interplay between water resources, urbanization, and poverty[5], [6].

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2. MATERIAL AND METHODS

2.1 STUDY AREA

The study was conducted inarea near the Raichur, located between Krishna and Tungabhadra rivers, is the headquarters of Raichur district. The study area is Manchalapur tank and it is located 10 km away from Raichur city.The study area is situated in the North-Eastern dry zone (Zone-2) of Karnataka located at 16° 14'N latitude and 77° 19'E longitude and at an elevation of 380 m above mean sea level. Average rainfall of the area is 875.3 mm. The monthly mean maximum and minimum temperatures of the area were recorded in May and January as 44.34°C and 10.39°C respectively. .The water present tank was commonly used for irrigation, fish rearing and domestic purpose.

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2.2 COLLECTION OF WATER SAMPLE

Water samples were collected from the inlet of tank where the sewage enters into tank, two locations of water spreading area of the tanks and outlet of the Manchalapur tank (Fig. 1). The water samples were collected during post-monsoon (November to February) and Monsoon (June-October) in the medical grade autoclavable polyethylene bottles of 250 ml capacity and stored at 4°C in a refrigerator.

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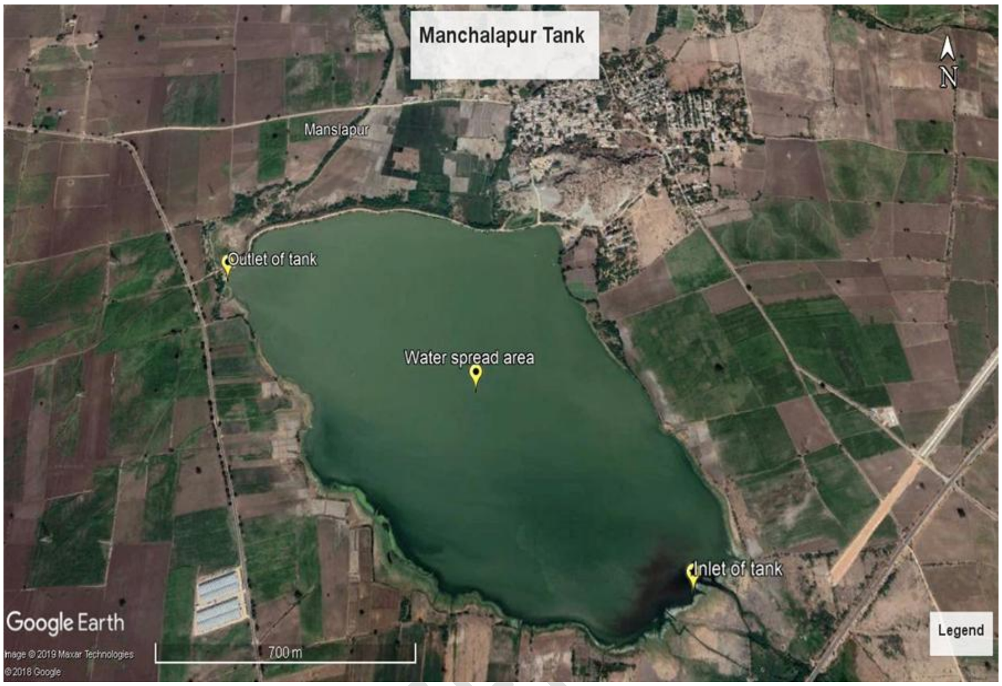

Fig 1. Satellite image of the Manchalapurtank obtained from Google earth.

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Table 1. Standard methods used for water quality parameter analysis

Sl. No.	Parameter	Methods	Irrigation water quality standards	Units
1	pH	Glass electrode method	6.5-8.5	-
2	Electrical Conductivity	Conductivity bridge method	2.0	dS m^{-1}
3	Total Dissolved Solids	Gravimetric method	2100	mg L^{-1}
4	Carbonates and Bicarbonates	Titrimetric method	-	meq L^{-1}
5	Nitrate	Kjeldhal method	50	mg L^{-1}
6	Phosphate	Stannous chloride method	-	mg L^{-1}
7	Calcium and magnesium	VersanteTiration	-	mg L^{-1}
8	BOD5	Incubation method	100	mg L^{-1}
9	COD	Mercury free digestion method	-	mg L^{-1}
10	DO	Titrimetric method	6	mg L^{-1}
11	Turbidity	Nephelometric method	-	NTU

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3. RESULT AND DISCUSSION

3.1 PHYSICAL PARAMETERS

The municipal water samples (Manchalapur tank) that were collected during the study was appeared light blackish in colour at inlet and light greenish colour at the outlet and tank water storage area. The greenish colour indicated the presences of the abnormal amount of nutrients present in the water and increased the amount of phytoplankton productivity in the water. The blackish colour indicated the presence of the colloidal particles. The municiplewater samples was inquired with an odd odour that may be due to the

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decomposition of organic matters present in the water over time or due to the septic contamination or addition of various chemicals.

3.2 CHEMICAL PARAMETERS

3.2.1pH and EC

pH is a measure of the hydrogen ion (H^+) activities that decide the acidic or alkaline condition of water. The mean pH recorded in the manchalapur tank, highest in post monsoon season (8.15) and lowest in monsoon season (7.89)as depicted in Fig.2. The recommended pH for irrigation water is in the range of 6.0-8.5. The results showed that, pH recorded in both the season were within the recommended range. The slight alkaline nature of water may be due to the presence of bicarbonate ions, which was produced by the combination of CO_2 with water to form carbonic acid, which affects the pH of the water [1].

EC gives the concentration of soluble salts present in the water. The value of mean EC in monsoon season (1.41dSm^{-1}) and in post monsoon season (1.48 dSm^{-1}).The results showed that, mean EC value during both the season are found to be within the permissible limit standards for irrigation purpose. The lesser the value of electrical conductivity the lesser will be the dissolution of carbonate minerals and other ionic species in water

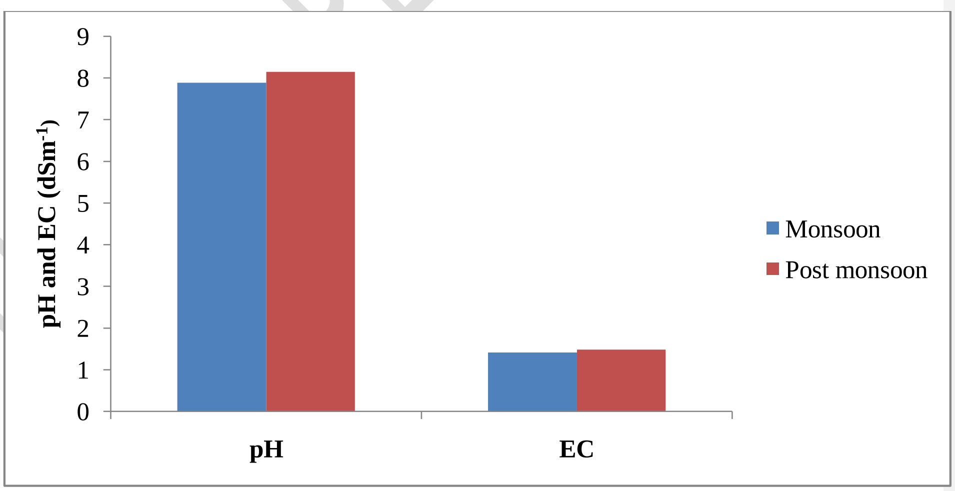

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Fig. 2: Concentration of pH and EC (dS m^{-1}) of samples in monsoon and post monsoon season

3.2.2 Total dissolved solids (TDS)

TDS represent all the inorganic and organic substances contained in a wastewater in molecular and/or micro-granular form. The mean TDS value of monsoon season was 929.63 mg L^{-1} andin post monsoon season was 1031.56 mg L^{-1} as graphically represented in Fig. 3. The result reveals that the observed TDS is within the range of recommended TDS for irrigation purpose. The mean TDS value in post monsoon season was found more when compared with monsoon season due to the addition of same amount of municipal sewage to lesser amount of water during post monsoon [2].

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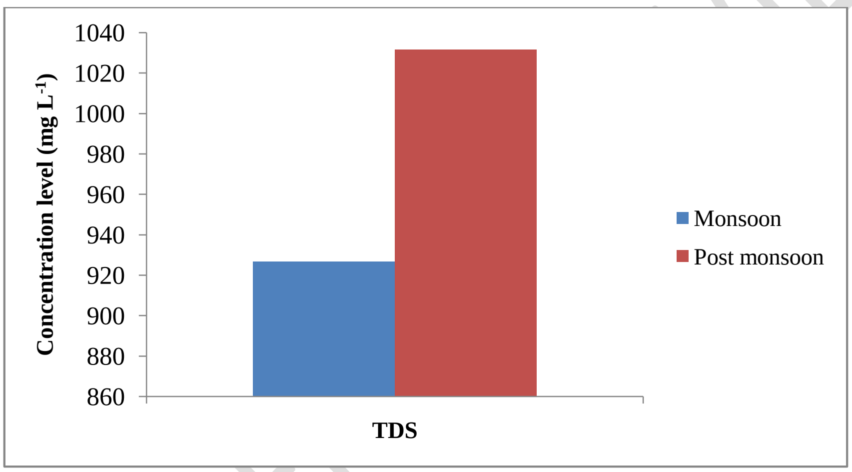

Fig. 3: Concentration of TDS of samples in monsoon and post monsoon season

3.2.3CARBONATE AND BICARBONATE

The result reveals that, the mean carbonate and bicarbonate value were more in monsoon season compared to post monsoon season. The value of carbonate in monsoon season and post monsoon season were 2.15meq L^{-1} and 0.86meq L^{-1} respectively. The value of bicarbonate in monsoon and post monsoon were 7.71meq L^{-1} and 4.49meq L^{-1} respectively (Fig. 4)

3.2.4NITRATE AND PHOSPHATE

From the fig. 5, the nitrate concentration was recorded lowest in monsoon season (26.90 mg L^{-1}) compared to post monsoon season (34.09 mg L^{-1}). The standard nitrate concentration for both drinking and irrigation water is 45 mg L^{-1}. The observed value is less than recommended value. The presence of nitrate in the water sample at the present study, fulfill the need of nitrate required for the plant growth to some extent and hence nitrate application in the form fertilizer were reduced.

Fig.6 show, the mean phosphates level was the highest in the monsoon season (9.85 mg L^{-1}) and lowest in post monsoon season (6.20 mg L^{-1}). The mean Phosphate value was found to be more during monsoon season when compared with post monsoon, due to the addition of domestic waste water, particularly those containing detergents as well as runoff from various sources containing fertilizers to the tank [1].

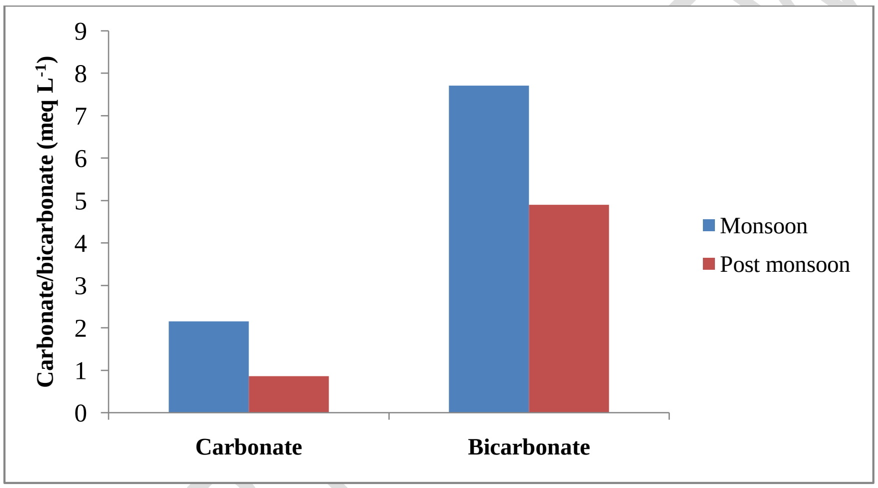

Fig. 6: Concentration of carbonate and bicarbonate (meq L^{-1}) of samples in monsoon and post monsoon season

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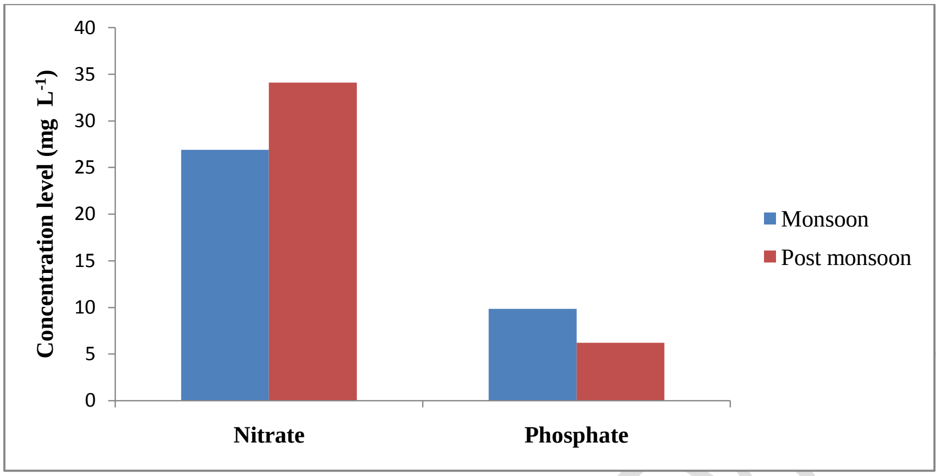

Fig. 7: Concentration of nitrate and phosphate (mg L^{-1}) of samples in monsoon and post monsoon season

3.2.5CONCENTRATION OF CATIONS

The cations present in water samples are calcium, magnesium and sodium. Characterization of manchalapur tank water, showed that the concentration of calcium were 3.38 mg L^{-1} in monsoon season and 2.77 mg L^{-1} in post monsoon season, whereas magnesium were found 5.16 mg L^{-1} in monsoon season and 4.13mg L^{-1} in post monsoon season respectively (Fig 5).

High value of calcium and magnesium is due to the domestic waste water and effluent present in the sewage or due to the cationic exchange with sodium, however low value do not mean that it is not influenced by the pollutant but it may be due to the reverse cationic exchange with sodium.The sodium concentration was 0.85mg L^{-1} and 0.92mg L^{-1} in monsoon season and post monsoon season respectively..

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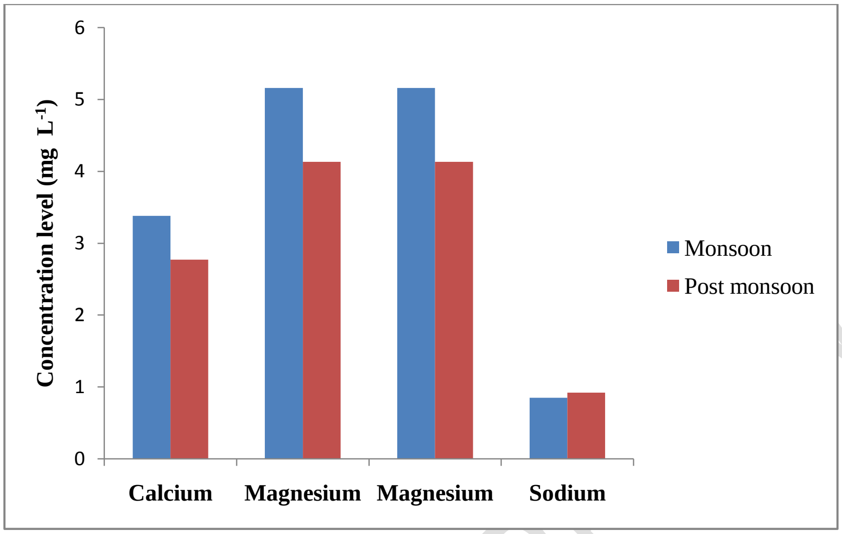

Fig. 8: Concentration of calcium, magnesium and sodium (mg L^{-1}) of samples in monsoon and post monsoon season

3.2.6 BIOCHEMICAL OXYGEN DEMAND (BOD_5), CHEMICAL OXYGEN DEMAND(COD) and DISOLVED OXYGEN (DO)

ThemeanBOD$_5$was 1396.88mgL^{-1}and1252.31 mg L^{-1}in monsoon and post monsoon seasonrespectively. The BOD at both the seasons appeared to be higher than the irrigation standard of 100 mg L^{-1}.The mean COD recorded was the highest, 24549 mg L^{-1}in monsoon season compared to 8573 mg L^{-1} in post monsoon seasons. The higher COD level indicates the greater amount of oxidizable organic material in the water sample, which will reduce dissolved oxygen level. It lead to the anaerobic conditions, which is deleterious to higher aquatic life forms.The mean DO value in the monsoon season was 7.91 mg L^{-1} and in post monsoon season 8.02 mg L^{-1}. The result showed that the mean DO value difference between monsoon and post monsoon were not much.

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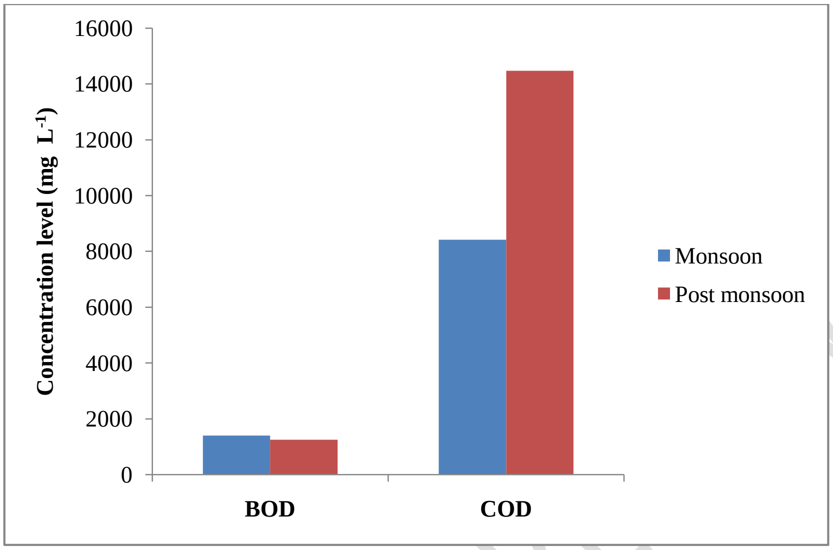

Fig. 9: Concentration BOD and COD (mg L^{-1}) of samples in monsoon and post monsoon season

3.2.6 TURBIDITY

Turbidity is the elementary measure of the suspended solids in the wastewater and generally measured using principle of scattering of light. The mean turbidity value higher in monsoon season (13.33 NTU) compared to post monsoon season (8.77 NTU). The low turbidity of water was found due to lack of runoff resulting from the area during post monsoon.

Turbidity was found relatively high in monsoon season due to addition of dissolved fertilizers, pesticides, herbicides and other particles from the agriculture land to the tank (Augustine *et al*, 2016)

The mean turbidity value was high compared to the recommended value. The higher turbidity affects organisms that are directly dependent on light, like aquatic plants because it limits their ability to carry out photosynthesis. This in turn, affects fishes that depend on these plants for food and oxygen. Dissolved oxygen is an important parameter to indicate the purity and reactiveness of water.

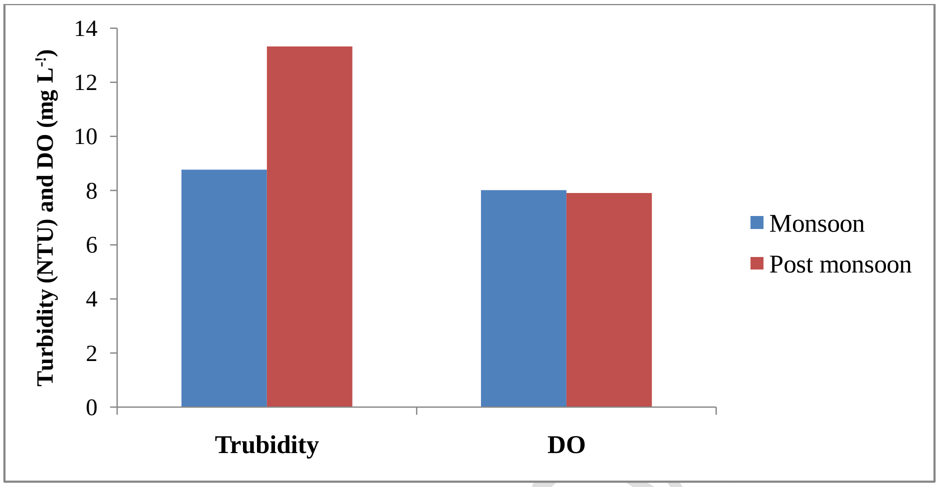

Fig. 10: Concentration turbidity (NTU) and DO (mg L^{-1}) of samples in monsoon and post monsoon season

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4. CONCLUSION

Water is essential for sustaining life, but increasing population, urbanization, and agricultural expansion have led to the deterioration of tank water quality. While quantity matters, the quality of water is equally crucial. Research findings indicate that all water quality parameters meet permissible irrigation standards, including dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and turbidity. However, the high concentration of dissolved oxygen (>5 mg L-1) in tank water renders it unsafe for aquatic life. Although water samples used for irrigation contain anions such as nitrate and phosphate, meeting some agricultural requirements, the study concludes that water must be treated before being used for irrigation purposes.

Treating sewage water for irrigation involves several steps to make sure it's safe for farming and doesn't harm people or the environment. First, they remove big stuff and dirt from the water. Then, they use bacteria or special filters to clean it more. After that, they might use things like chlorine or UV light to make it even cleaner. Sometimes, they take out extra nutrients to keep the water from causing pollution. In some places, they use fancy methods like special filters to make the water super clean. Finally, they store the clean water and move it to the fields through pipes or canals.

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