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WATER QUALITY CONSTITUENTS AND PERFORMANCE OF THE WATER TREATMENT PLANT

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ABSTRACT:
Raw water pumped from the reservoir/river contains a variety of physical, chemical and biological impurities that are important considerations in providing safe drinking water for people. The study was undertaken to determine the total loads of water quality constituents in the raw water from the Erai River water carrying pipeline (Raw water) and the performance of the water treatment plant (WTP) in the city of Chandrapur. WTP includes treatment facilities such as aeration, clariflocculation, filtration, overhead tank storage and distribution. The raw river water and water treatment plant constituents were sampled and analysed in accordance with the Standard Procedures for the Examination of Water and Wastewater. The result shows that raw water combined with heterogeneous physical, chemical and biological constituents that require treatment, while the performance of the treatment units is better at every stage.

Keywords: - Raw water, Erai River intake, WTP, Aeration, Clari flocculation, filtration.

INTRODUCTION :

The main sources of drinking water in the town of Chandrapur include water from the Erai River and the bore wells. All types of life on earth depend on water to survive (1). Rainfall and nearby water flow determine the quantity and quality of water in the river and all other water resources (2). Stored water at its origin is associated with most of the physical, chemical and biological impurities that are important to be removed prior to its use for various purposes. Physical, chemical and biological characteristics in water are mainly due to natural initially and later anthropogenic factors make it more enriched with toxic constituents. It is highly important to examine the physicochemical and biological characteristics of the raw water, including impurities from the Erai River intake and its treatment in the WTP in Chandrapur city so that the effectiveness and performance of the water treatment plant can be evaluated.

MATERIALS AND METHODS :

The methodology adopted for this piece of research includes the sampling, preservation of the water sample and analysis of the water samples as per the Methods for the Examination of Water and Wastewater (APHA, AWWA, and WPCF, 2012(3). The parameters such as temperature, electric conductivity, pH, colour, and odour were recorded on the spot itself. Dissolved oxygen bottles were used to collect water samples for analysis on the same day. Water samples for BOD and biological samples were stored at 4°C temperature in darkness. Standard method was used for the preservation of the water samples for other water quality parameters. Plankton is counted using the Sedgewick Rafter Counting Cell. Water samples

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were also collected from WTP's Aeration Unit, clariflocculation and Rapid sand filtration Unit.

RESULTS AND DISCUSSION :

Location of Study Area and Sampling Stations

The Chandrapur City (Coordinates: 19.9615° N, 79.2961° E) is situated at the bank of the Erai River and Zarpat River which flows through the city. Erai River supplies water to Chandrapur city from Erai Dam and 30 % water supply of Chandrapur City is drawn from Erai River, Datala Road, intake belt. Raw water sampling stations were fixed on Erai water intake air valve kept at regular points in water pipeline. Sampling station at Outlet of each treatment unit of WTP decided as per rules and regulations of the competent authority.

Physicochemical and biological characteristics of Erai River intake raw water

The suitability of water is determined by its physical, chemical, biological, and organoleptic (taste-related) properties. The quality of river water in-situ is not noticeably improved, although it varies from season to season. Water samples taken from surface water from the morning to the evening demonstrate fluctuations in physical, chemical, and biological contents. These changes are natural and do not affect river water quality in the long term unless pollutants are introduced to surface waters. The river water pumped from the Erai intake contains the physicochemical and biological constituents mentioned in (Table 1) and its treatment in WTP (Table 2)

Odour in natural waters is associated with microbial activity and is a result of decomposition of organic matter and reduction of sulphate to hydrogen sulphide. The aeration unit improves taste by initially reducing odour from natural water by introducing air oxygen to the water and removing gases like carbon dioxide, H2S, and methane. Water aeration aids in solids stabilisation as well (4).

The amount of suspended particles, phytoplankton, and dissolved organic matter in surface water can alter its colour (5). The water intake of the Erai River is colourless, ensuring the aesthetic quality of the river's water.

Turbidity

The presence of microflora, microfauna, and decomposing materials are all indicated by turbidity in natural water, which can raise the cost of water treatment in a water treatment plant (6). Turbidity values in this study are slightly higher (15 mg/l) during the rainy season because of the high amount of sediments in the form of runoff. A water treatment plant can effectively remove excess turbidity in the clariflocculation and filtration unit (Table 2).

Temperature

When evaluating the quality of the water, temperature is an essential consideration. The effects of temperature on biological activity and growth are profound. Temperature affects photosynthetic production, metabolic rates, and dissolved oxygen and other dissolved gas concentrations in water treatment plants in addition to its own impacts (7). The temperature of the raw water used in this study is in accordance with the atmosphere, although the temperature of the aeration, clariflocculation, and filtration units varies slightly (29–29.5°C).

pH

The aquatic species in the river will be harmed if the pH of the water is too high or too low.The solubility and toxicity of substances in the water can both be impacted by pH. While certain aquatic organisms can survive in water with pH values outside of this range, most prefer a pH range of 6.5 to 9.0 (8). The pH of the raw water is ideal throughout the rainy season and during the winter, but during the summer the solubility of oxygen decreases owing to warmth, making it somewhat low 6.9. The WTP's aeration unit effectively reduces atmospheric carbon dioxide, and the addition of oxygen causes the pH of the

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water to rise to 8 (Table 2), which is then slightly lowered to 6 to reach the desired, acceptable level.

TDS

Total dissolved solids can also affect water taste and are frequently indicative of high alkalinity or hardness. Higher levels of total dissolved solids in bodies of water, such as rivers, frequently harm aquatic species. Total dissolved solids modifies the mineral content of the water, which is important for survival of many aquatic animals. The minerals most often dissolved are calcium, magnesium, potassium, sodium, bicarbonate, chlorides and sulphates (9). TDS in raw water is higher (300mg/l) during the rainy season due to run-off and stabilises in the winter (140mg/l) and summer (160mg/L). TDS begins to decrease in WTP from the aeration unit to the clariflocculation unit to the filtration unit (150 mg/l).

Hardness

Hardness levels above a certain threshold are undesirable for economic or aesthetic reasons (10). Raw water always has hardness due to divalent cations; its value is higher in the rainy season (210 mg/l), decreases in the winter (160 mg/l), and is slightly higher in the summer due to evaporation (170 mg/l). In a water treatment plant hardness right from aeration unit and up to filtration goes on decreasing because of effective treatment and removal of divalent cations from water by the sand bed filter (125 mg/l).

Total Alkalinity

The main function of total alkalinity is to help control the pH of the water. Alkaline compounds in water, such as hydroxides and carbonates, remove H+ ions from the water, lowering the acidity and resulting in a higher pH (11). The total alkalinity concentration of raw water is higher (310mg/l) due to the presence of hydroxides, carbonate, and runoff during the rainy season. Total alkalinity value in WTP increased from aeration unit(245mg/l), but decreased from clariflocculation unit(230mg/l) due to excess generation of dilute sulfuric acid by alum addition. In the filtration unit, alkalinity values increase (240mg/l) to maintain the optimum concentration.

Chloride

The most common source of chloride is dissolved salts such as sodium chloride or magnesium chloride. In plants and animals, chloride is required in trace amounts for normal cellular function. Chloride (Cl) is one of the most abundant and common ions found in water, and its detection and quantification are significant in controlling the quality of drinking water. Chloride concentrations above 250 mg/litre may have an effect on the taste of the water (12). The runoff contains soil and sediments, which contain sodium and chloride salts, thus increasing the chloride concentration in the water. The removal of chloride in water treatment plants is minimal, but the concentration of chloride is within acceptable limits (120mg/l).

Dissolved oxygen

One of the most important indicators of water quality is dissolved oxygen (DO). It is necessary for fish and other aquatic organisms to survive. Because of the aerating action of the winds, oxygen dissolves in surface water. Additionally, as a by-product of photosynthesis in aquatic plants, oxygen is added to the water. Phytoplankton maintains the oxygen concentration in raw water, although the presence of microfauna like zooplankton also depletes it (13). Nevertheless, the concentration of dissolved oxygen in raw water is still within an acceptable range (6 mg/l). The amount of oxygen is always greater (8 mg/l) in the water treatment plant's aeration unit, but it continues to decrease throughout clariflocculation (7 mg/l), ensuring that the ideal concentration of DO is maintained before distribution (6 mg/l).

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Sulphate

Sulphates (SO4--) can occur naturally; when they do, they are frequently the result of the breakdown of leaves that fall into a river or water passing through rock or soil containing gypsum and other common minerals, or of atmospheric deposition. Sulphates are also added to water bodies by runoff from fertilised agricultural lands (14). Rainy season runoff contains slightly more sulphate (60mg/l) than winter and summer. Water treatment plants use various treatment units to remove sulphate concentrations (45mg/l).

Phosphate

Phosphorus is commonly regarded as the "limiting nutrient" in aquatic ecosystems; however, in sufficient quantities, phosphorus can be used by vegetation and soil microbes to support normal growth (15). Phosphate concentration has a limiting concentration in the rainy season (1.5mg/l) and continues to decrease in the winter and summer. The water treatment plant effectively removes phosphate from the aeration unit to the filtration (1.0 mg/l).

Nitrate

Nitrates are essential plant nutrients, but excessive amounts can cause serious water quality issues. Nitrate in drinking water is toxic to young animals, including humans (16,17). The runoff (2.5mg/l) is the source of nitrate in river water, and the concentration is not particularly high, which is cause for concern. Nitrates (1.2mg/l) are effectively removed from raw water by the water treatment plant.

Biochemical oxygen demand

The biochemical oxygen demand is an important parameter for determining the quality of water. It is concerned with the amount of oxygen consumed by aerobic biological organisms in order to oxidise organic compounds (18). Although the BOD value in river water is very low (10mg/l), the water treatment plant is effective in removing whatever BOD is present in the water.

Chemical oxygen demand.

As the concentration of organic matter increases, so does the chemical oxygen demand. COD increases as the concentration of organic material increases. It also increases if inorganic compounds are present (19). Raw river water is deficient in decaying organic matter. The Water treatment plant is effective to remove the fraction of COD.

Plankton

A significant source of dissolved oxygen is phytoplankton. These plants produce oxygen during the day through photosynthesis far more quickly than oxygen can penetrate into the river water from the atmosphere. They serve as the foundation of the entire marine food chain. Growth of phytoplankton is reliant on the presence of carbon dioxide, sunshine, and nutrients (20). Plankton populations in river water are very low because the raw water lacks nutrients. Various treatment techniques used in water treatment plants to remove plankton.

Free chlorine

Free chlorine is a sign of potable water since its presence in drinking water is associated with the lack of pathogenic microorganisms. Chlorine gas is added to the water treatment facility to disinfect the water. Free chlorine concentrations of up to 0.3 mg/l (Ortho-toluidine test) were observed in an elevated water tank.

CONCLUSION :

Drinking water accessibility, both in terms of quality and quality, is crucial for people. Raw water obtained from the river contains a variety of total dissolved solids as well as impurities. A water treatment facility demonstrates the efficient aeration, clariflocculation and filtration of drinking water.

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Table 1-Physicochemical and biological parameters of Erai River intake (Raw Water)

Sr. No.	Water quality parameter	Season		
		Rainy	Winter	Summer
1.	Taste	Agreeable	Agreeable	Agreeable
2.	Odour	Agreeable	Agreeable	Agreeable
3.	Colour, Hazen units	Colourless	Colourless	Colourless
4.	Turbidity (NTU)	15	10	08
5.	Temperature °C	29	27	30
6.	pH	7.5	7.8	6.9
7.	Total dissolved solids mg/l	300	140	160
8.	Total Hardness mg/l	210	160	170
9.	Total alkalinity mg/l	310	230	215
10.	Chlorides mg/l	160	120	110
11.	Dissolved oxygen mg/l	6.0	7.0	5.0
12.	Sulphate mg/l	60	40	50
13.	Phosphate mg/l	1.5	1.0	1.0
14.	Nitrate mg/l	2.5	2.0	1.8
15.	BOD mg/l	10	10	10
16.	COD mg/l	30	BDL*	10
17.	Plankton, Organisms/l	50	40	60

BDL*-Below detectable limit

Table 2-Treatment of raw water in water treatment plant (WTP)

Sr. No.	Water quality parameter	Water Treatment Plant		
		Aeration Unit	Clariflocculation Unit	Filtration Unit
1.	Taste	Agreeable	Agreeable	Agreeable
2.	Odour	Agreeable	Agreeable	Agreeable
3.	Colour, Hazen units	Colourless	Colourless	Colourless
4.	Turbidity (NTU)	8	BDL	BDL
5.	Temperature °C	29.5	29.5	29
6.	pH	7.8	7.3	7.5
7.	Total dissolved solids mg/l	240	180	150
8.	Total hardness mg/l	150	140	125
9.	Total alkalinity mg/l	245	230	240
10.	Chlorides mg/l	140	130	120
11.	Dissolve oxygen mg/l	8	7	6
12.	Sulphate mg/l	50	55	45
13.	Phosphate mg/l	1.2	1.0	1.0
14.	Nitrate mg/l	1.8	1.5	1.2
15.	BOD mg/l	BDL*	BDL*	BDL*
16.	COD mg/l	BDL*	BDL*	BDL*
17.	Plankton,org/l	10	BDL*	BDL*
18.	Free Chlorine mg/l	BDL*	BDL*	BDL*

BDL*-Below detectable limit

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Figure1-Physicochemical and biological parameters of Erai River intake (Raw Water)

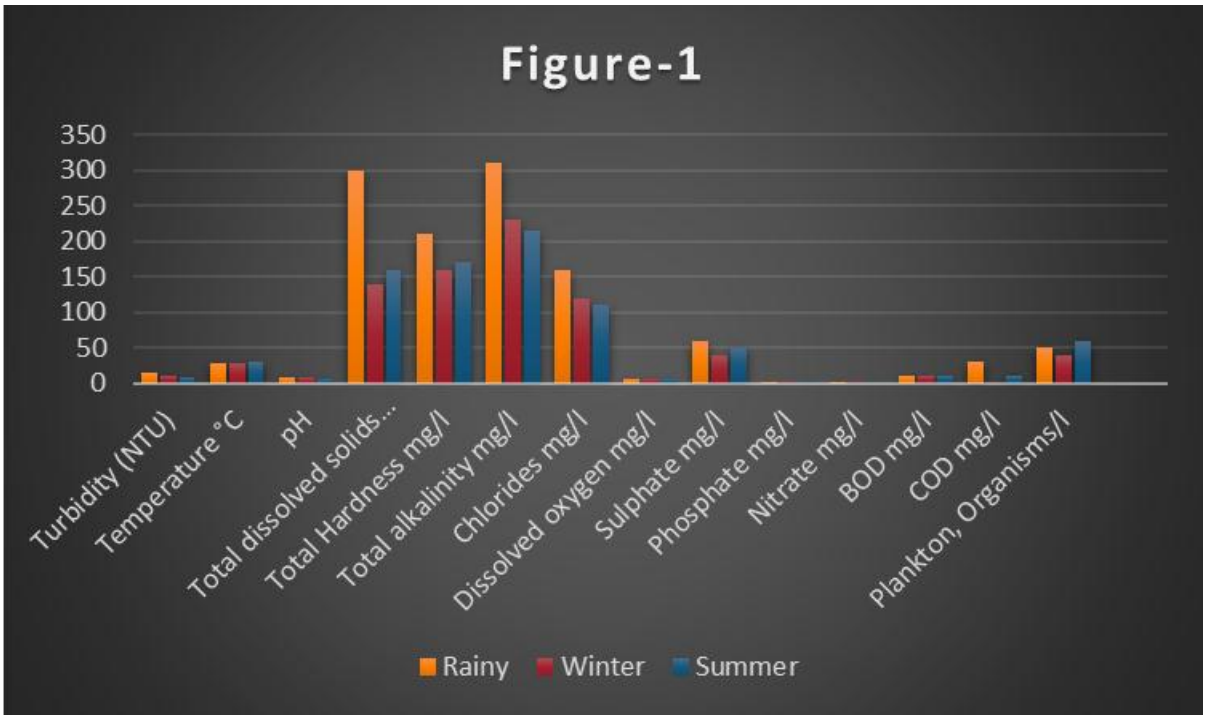
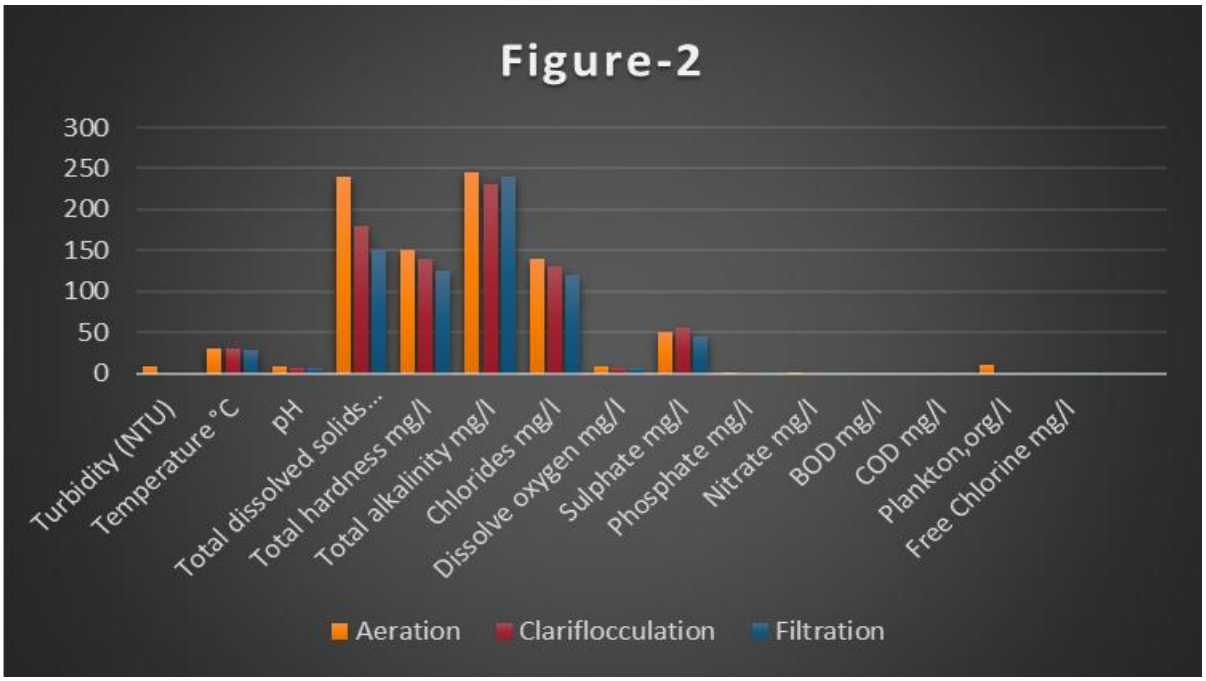


Figure 2-Treatment of raw water in water treatment plant (WTP)



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