ASSESSMENT OF PHYSICO-CHEMICAL AND MICROBIOLOGICAL PARAMETERS OF YEDGAON DAM WATER FOR IRRIGATION SUITABILITY

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Abstract:

The quality of drinking water resources is critical for public health, particularly due to the potential entry of pollutants and nutrients that can lead to bioaccumulation and biodiversity risks. This study focuses on the Yedgaon Dam, an earthfill and gravity dam on the Kukadi River near Junnar, Pune district, Maharashtra, India, primarily serving irrigation purposes. The water from Yedgaon Dam is vital for agricultural activities in Yedgaon village. A comprehensive physico-chemical and microbiological analysis was conducted to assess the suitability of this water for irrigation. Parameters such as color, pH, temperature, nitrite, nitrate, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness, phosphate, alkalinity, salinity, chloride, sulphite, sulphate, calcium, magnesium, phosphorus, and microbiological indicators were measured. The findings indicate that all parameters fall within the standard ranges specified by the World Health Organization (WHO), affirming the water's suitability for irrigation purposes**.**

Keywords: Yedgaon Dam, Water quality, Physico-chemical parameters, Microbiological study

1. Introduction:

Water is one of the most crucial and abundant compounds in the ecosystem, essential for the survival and growth of all living organisms on Earth [1]. Currently, Earth is the only known planet with about 70% of its surface covered in water. However, human activities such as population growth, industrialization, agricultural practices using fertilizers, and various other anthropogenic activities have led to significant contamination of water sources with harmful pollutants. This increasing pollution highlights the necessity of regularly monitoring the quality of drinking water. Contaminated drinking water can lead to numerous waterborne diseases [2], posing severe health risks to human populations. Understanding the complex biological phenomena associated with water quality is challenging, but studying the chemistry of water can reveal much about the metabolism of ecosystems and clarify hydro-biological relationships (Basavaraja Simpi et al., 2011).

Water quality is assessed based on its physical, chemical, biological, and aesthetic properties. These parameters are critical for determining the suitability of water for various uses, including human consumption and the maintenance of healthy aquatic ecosystems. Natural water bodies exhibit a wide range of chemical compositions, influenced by various physical and chemical processes (Kedar et al., 2008). Regular water quality assessment is essential for identifying pollution levels and informing conservation efforts. The presence of high concentrations of organic and inorganic compounds can lead to anomalous behavior in water bodies, affecting both ecological balance and human health (Dohare et al., 2014). Studies, such as those conducted by Meitei et al. (2004), have shown that pollution trends are exacerbated by sewage discharge and other anthropogenic activities, underscoring the need for effective management and mitigation strategies to protect water resources. The aim of this research is to evaluate the current state of drinking water quality, identify the primary contaminants, and assess their impact on both human health and the ecosystem. By regularly monitoring these parameters, we can develop better strategies for water resource management, ensuring the protection and sustainability of this vital resource.

2. Materials and methods:

The study was conducted on the Yedgaon dam from four sampling sites, these were S1, S2, S3 and S4 for the analyzed these parameters such as pH, Temperature, Nitrite, nitrate, TDS, TSS, DO, BOD, COD, Total hardness, Alkalinity, Salinity, Chloride, Sulphite, Sulphate, Nitrite, Nitrate, Calcium, magnesium, phosphate, phosphorous and microbiological parameters. All the parameters analyzed by using standard method of APHA.

3. Study area:

The Yedgaon Dam stands 29.74 meters (97.6 feet) tall from its lowest foundation and extends 4,511 meters (14,800 feet) in length. It has a volume content of 1.004 cubic kilometres (241 cubic miles) and a gross storage capacity of 93.43 cubic kilometres (22,415.05 cubic miles). Situated in the Ghod basin, the dam is part of the Kukadi project, which encompasses the construction of five dams in the region. The total capacity of the project is 79.27 cubic kilometres (19,020 cubic miles), with a surface area of 1,700 square kilometres (660 square miles).

Fig 1:(a) Study map area (b) Sampling site

4. Result and Discussion:

All physico-chemical parameters of water samples collected from sampling sites S1, S2, S3, and S4 are presented in Table I.

i. pH:

pH, or potential hydrogen, of a solution refers to its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion activity at a given temperature. The permissible limit of pH in drinking water ranges from 6.5 to 8.5. In the present study, the pH values in all the collected water samples range from 7.5 to 7.9. Site S1 has the lowest value (7.5), while site S4 has the highest pH value of 7.9 as shown in Fig. 3.

ii. Temperature:

Temperature is crucial for its effect on other properties of wastewater. Temperature values for various samples are presented in Table 1, ranging from 27°C to 29°C. The highest value was found at site S4, followed by S3 and S2, while site S1 had the lowest temperature as depicted in Fig.4.

iii. Total Dissolved Solids (TDS):

The concentration of TDS is recorded as 400 mg/L for S1, 405 mg/L for S2, 407 mg/L for S3, and 406 mg/L for S4. These values are below the WHO standard of 2000 mg/L for the discharge of wastewater into surface water, indicating relatively low levels of dissolved solids in these samples as shown in Fig.7.

iv. Total Suspended Solids (TSS):

The total suspended solid (TSS) concentrations were found to be 202 mg/L for S1, 209 mg/L for S2, 213 mg/L for S3, and 274 mg/L for S4 (Table 1). These levels exceed the WHO guidelines of 50 mg/L for the protection of fisheries and aquatic life, indicating a significant presence of suspended particles as depicted in Fig.8.

v. Alkalinity and Salinity:

Low alkalinity causes corrosion of pipes and increases the chance of releasing heavy metals. The permissible value of alkalinity as recommended by the Indian Standards is 200 mg/L for CaCO3. The alkalinity concentration of the water samples collected in the study area ranged from 1.9 to 2.6 mg/L (Fig. 16). Salinity concentration was recorded as 2.9 mg/L for site S1, 2.7 mg/L for site S2, 2.4 mg/L for site S3, and 2.9 mg/L for site S4 (Fig.17).

vi. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD):

Biochemical oxygen demand is a measure of the quantity of oxygen consumed by is during the decomposition of organic matter. BOD concentrations of wastewater obtained for sites S1 to S4 ranged between 2.3 to 2.6 mg/L (Fig.12). Chemical oxygen demand (COD) is the oxygen requirement for the oxidation of organic and inorganic matter. The COD concentrations recorded were 2.5 mg/L for S1, 2.6 mg/L for S2, 2.6 mg/L for S3, and 2.3 mg/L for S4 (Fig.10).

vii. Dissolved Oxygen (DO):

DO is a measure of the degree of pollution by organic matter and the self-purification capacity of the water body. The maximum tolerance limit for fish is 5 mg/L, and levels below 2 mg/L can lead to death. DO values obtained for sites S1 to S4 were 3.4 mg/L, 4.5 mg/L, 5.2 mg/L, and 4.3 mg/L, respectively (Fig.9).

Sulphate, Nitrate, and Phosphate:

High amounts of sulphate impart a bitter taste to water and can cause laxative effects in children, especially in hot climates. Sulphate concentrations in the four sampling points ranged from 1.34 to 1.63 mg/L. Nitrate levels fluctuated between 0.2 mg/L and 0.7 mg/L, influenced by natural processes and the application of fertilizers. Phosphate levels, which enhance the growth of plankton and aquatic plants, exceeded the WHO maximum permissible limit of 5 mg/L, with levels ranging from 0.1 mg/L to 0.9 mg/L across the four sites.(Fig.6,Fig.15, and Fig.22).

viii. Sulphite, Nitrite, and Phosphorous:

The concentrations of sulphite, nitrite, and phosphorous at sites S1 to S4 were 1.38 mg/L, 1.34 mg/L, 1.67 mg/L, and 1.66 mg/L for sulphite; 0.08 mg/L, 0.09 mg/L, 0.05 mg/L, and 0.06 mg/L for nitrite; and 11.12 mg/L, 11.67 mg/L, 11.88 mg/L, and 12.15 mg/L for phosphorous, respectively (Fig.5 and Fig.15).

ix. Total Hardness, Calcium, and Magnesium:

Hardness in water is caused by dissolved calcium and magnesium, which can originate from sewage and industrial wastes. In the present study, calcium levels ranged from 76 mg/L to 82 mg/L, magnesium from 30 mg/L to 41 mg/L, and total hardness from 14.17 mg/L to 16.38 mg/L. These values are well within the WHO standard of 200 mg/L for hardness (Fig.11,Fig.19 and Fig. 20).

x. Chloride:

According to WHO, the allowable limit of chloride is 250 mg/L. Chloride levels in the four water samples ranged from 102 mg/L to 136 mg/L, which is within both the NSDWQ and WHO guidelines (Fig.18).

xi. Heavy Metals:

Heavy metal concentrations were determined spectrophotometrically and compared with WHO limits. The levels of cadmium (Cd) and arsenic (As) in the wastewater samples were below the limits set by WHO. Cadmium concentrations ranged from 0.01 to 0.02 mg/L, and arsenic ranged from 0.01 to 0.03 mg/L. Despite being below the permissible limits, heavy metal contamination can still pose risks and hazards to humans and ecosystems through direct contact, ingestion, food chain contamination, and reduced food quality (Fig.21).

Sr.No.	Parameters	Method	Site 1	Site 2	Site 3	Site 4
1	PH	Digital pH meter	7.5	7.4	7.5	7.9
2	Temperature (degree celcius)	Thermometer	27	28	28	29
3	Nitrite(mg/L)	Colorimetric method	0.08	0.09	0.05	0.06
4	Nitrate(mg/L)	Colorimetric method	0.7	0.6	0.2	0.2
5	TDS (mg/L)	Evaporation	400	405	407	406
6	TSS (mg/L)	Evaporation	202	209	213	274
7	DO (mg/L)	Wrinkler's iodometric	3.4	4.5	5.2	4.3
8	BOD(mg/L)	Wrinkler's iodometric	2.3	2.5	2.4	2.6
9	COD (mg/L)	Potassium dichromate	2.5	2.6	2.6	2.3
10	Total hardness(mg/L)	EDTA titrimetric method	14.17	15.06	16.34	16.38
11	Phosphorous(mg/L)	Molybdate method	11.12	11.67	11.88	12.15
12	Sulphite (mg/L)	Titration method	1.38	1.34	1.67	1.66
13	Sulphate(mg/L)	Turbidimetric method	1.34	1.52	1.63	1.35
14	Akalinity (mg/L)	Titration method	2.1	2.4	2.6	1.9
15	Salinity (mg/L)	Titration method	2.9	2.7	2.4	2.9
16	Chloride (mg/L)	Argentometric method	102	101	134	136
17	Magnesium (mg/L)	Titration method	30	32	38	41
18	Calcium(mg/L)	Titration method	76	78	81	82
19	Cadmium Heavy metal (mg/L)	Atomic absorption spectrophotometer	0.01	0.01	0.01	0.02
20	Arsenic Heavy metal (mg/L)	Atomic absorption spectrophotometer	0.01	0.02	0.01	0.03
21	Phosphate (mg/L)	Atomic absorption spectrophotometer	0.1	0.3	0.7	0.9

Table 1: Physico-chemical parameters of water

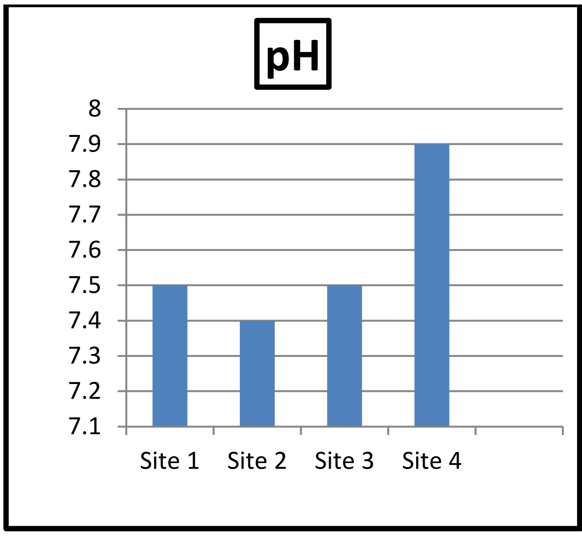


Fig: 3 Analysis of pH

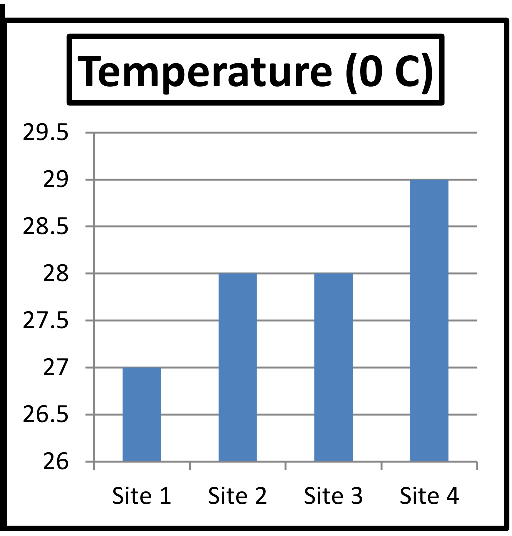


Fig: 4 Analysis of Temperature

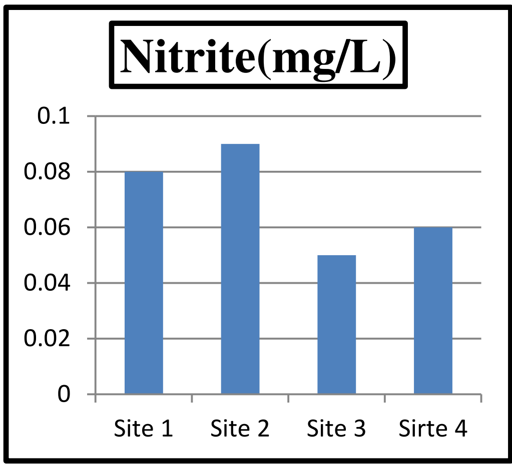


Fig: 5 Analysis of Nitrite

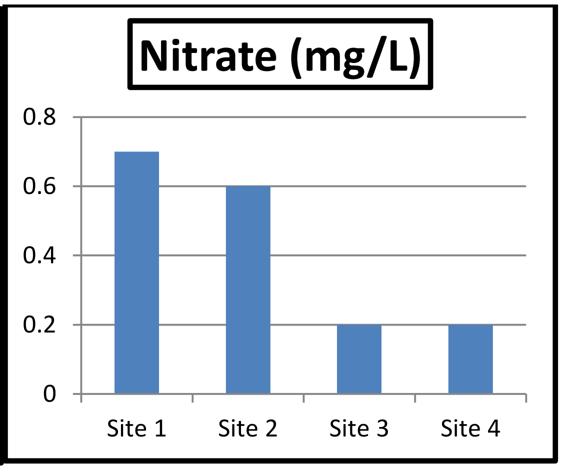


Fig: 6 Analysis of Nitrate

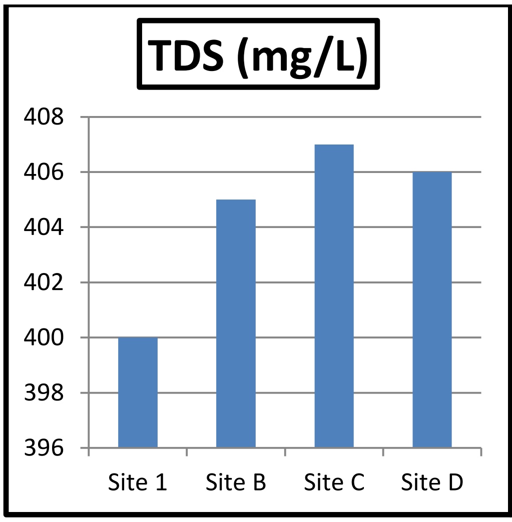


Fig: 7 Analysis of TDS

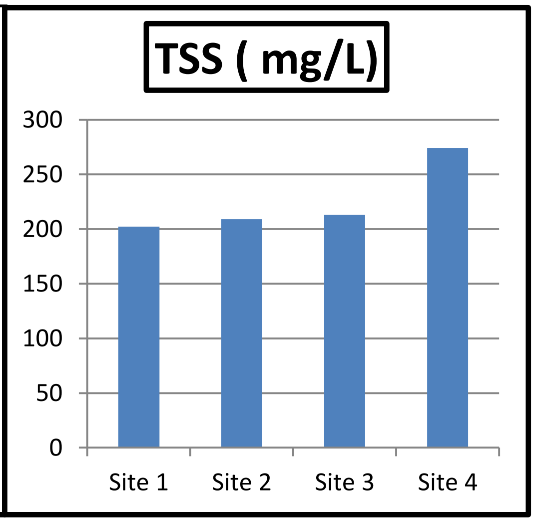


Fig: 8 Analysis of TSS

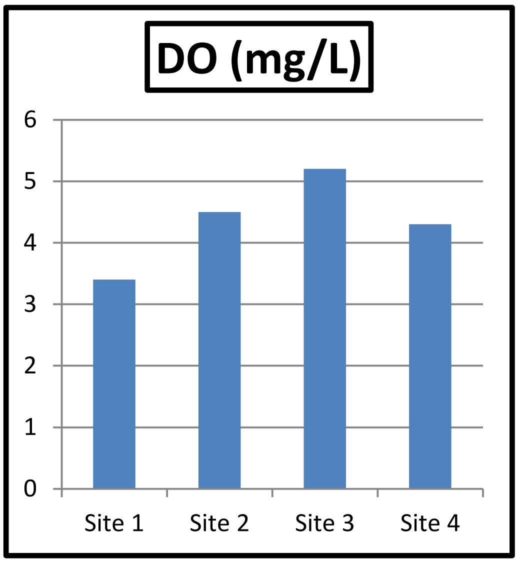


Fig: 9 Analysis of DO

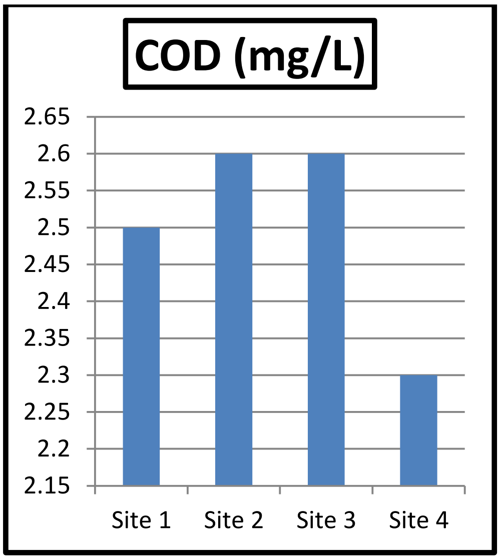


Fig: 10 Analysis of COD

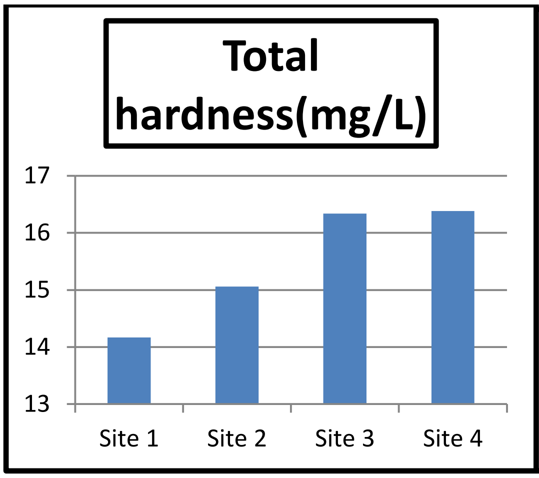


Fig: 11 Analysis of Total hardness

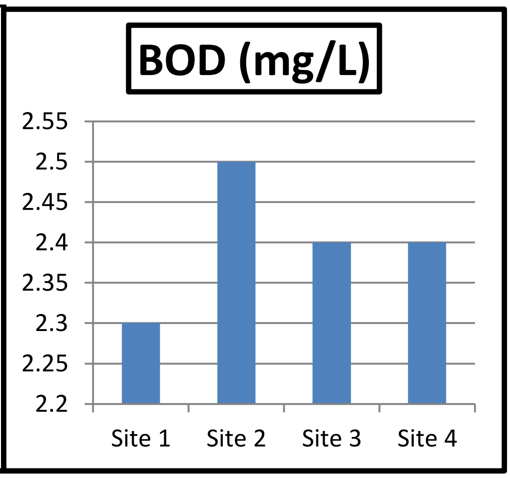


Fig: 12 Analysis of BOD

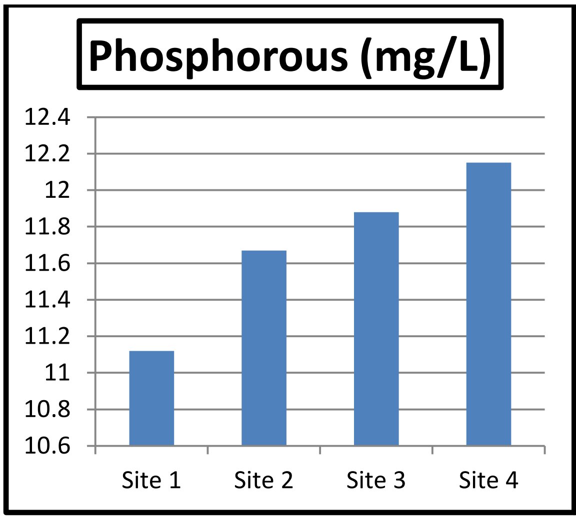


Fig: 13 Analysis of Phosphorous

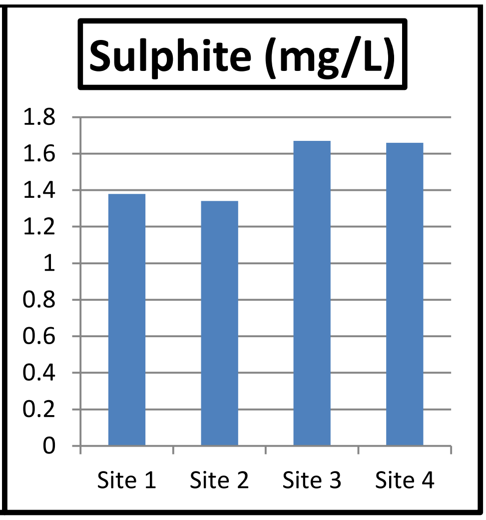
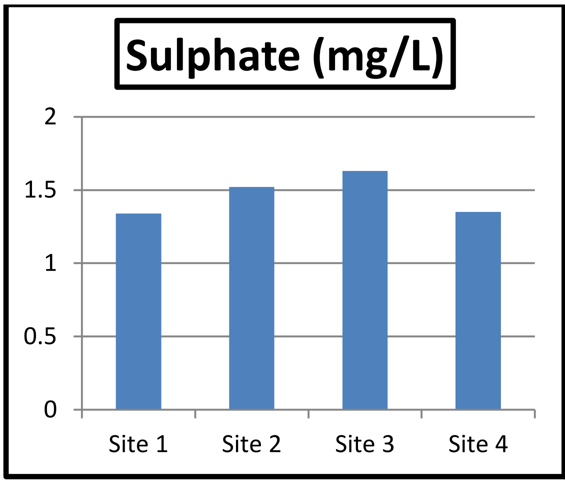


Fig: 14 Analysis of Sulphite



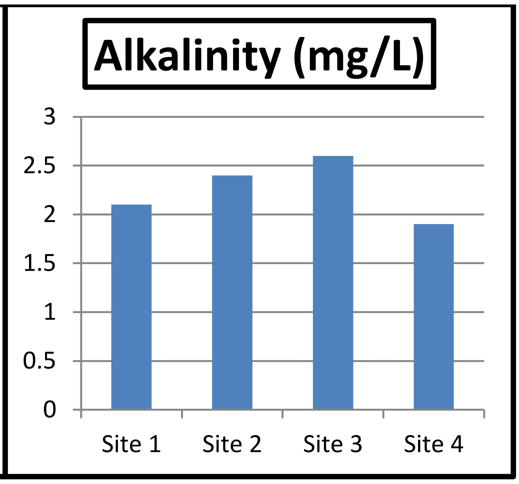
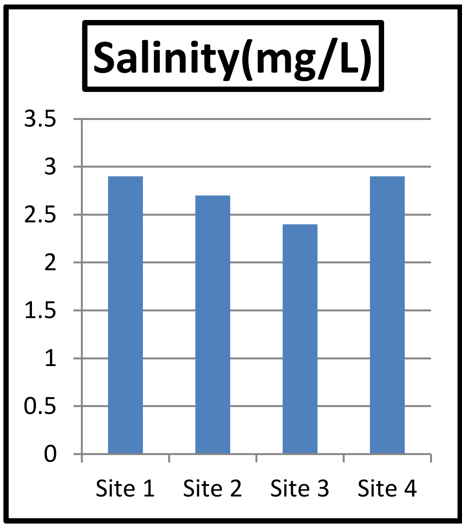


Fig: 15 Analysis of Suplphate

Fig: 16 Analysis of Alkalinity



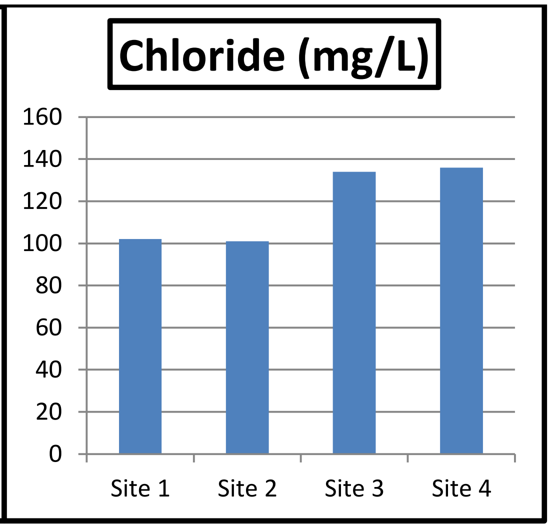
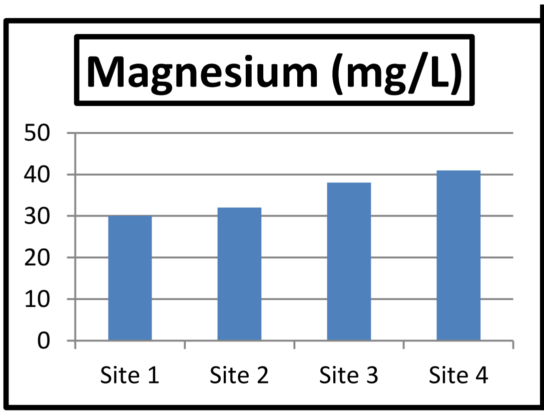


Fig: 17 Analysis of Salinity

Fig: 18 Analysis of Chloride



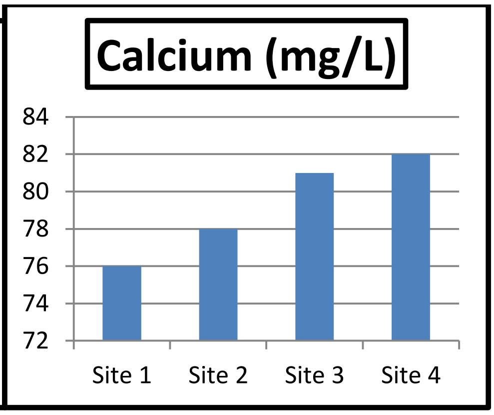


Fig: 19 Analysis of Magnesium

Fig: 20 Analysis of Calcium

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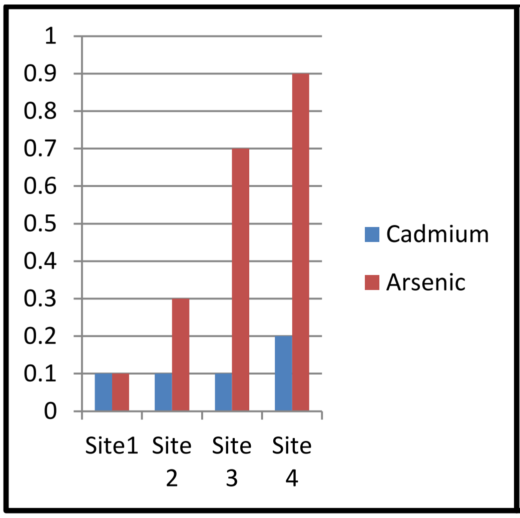

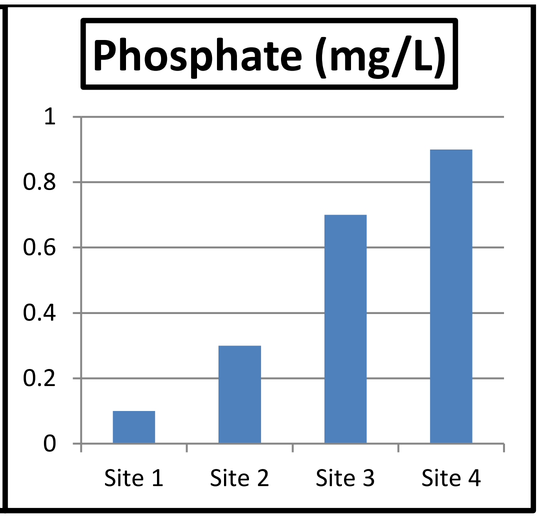

Fig: 21 Analysis of Heavy metals

Fig: 22 Analysis of Phosphate

xii. Microbiological study:

For microbiological study, water sample were examined under microscope. Microbiological study revealed the presence of bacteria, and these organisms serves as indicators for pollutants (20). Phytoplankton and bacteria have a greater effect on water quality than do other aquatic microorganisms. Phytoplankton are the main primary producers while bacteria are responsible for the majority of organic matter decomposition and nutrient recycling. In present study amoeba, Daphnia occidentalis, Lepadella patella, Calanus pacificus

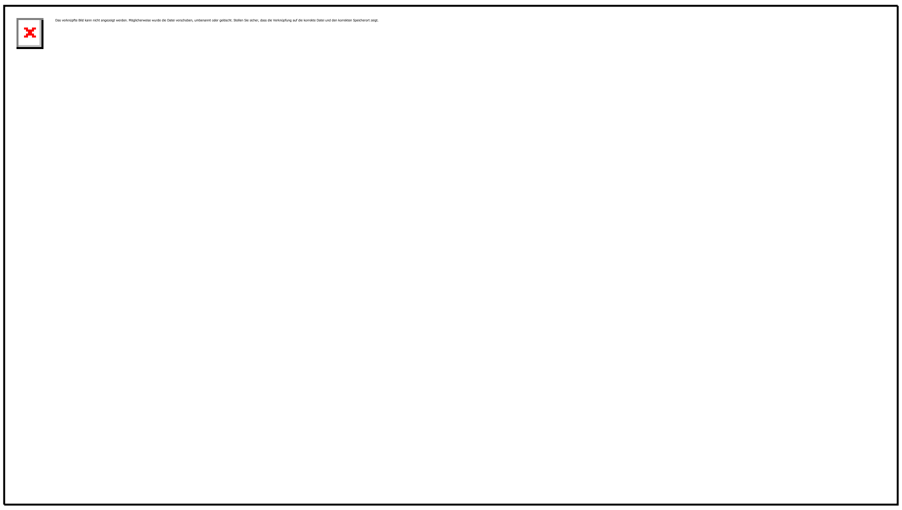

Fig 23: Microorganisms under microscope (a) Amoeba (b) Daphnia occidentalis c) Lepadella patella d) Calanus pacificus

After experimental analysis, it has been revealed that the water quality of Yedgaon Dam was found to be within acceptable limits according to WHO standards for most parameters, indicating that it is generally safe for drinking, irrigation, and domestic use. However, continuous monitoring and a long-term study covering all aspects of the water ecosystem are recommended to ensure sustained water health and safety.

Conclusion:

The present study was conducted on the Yedgaon Dam in Dist. Pune, where the water is used for drinking, irrigation, and other domestic purposes. It is crucial to monitor the water quality to ensure its safety and usability. Various parameters, including pH, temperature, TSS, TDS, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total hardness, calcium, magnesium, chloride, alkalinity, salinity, nitrite, sulphite, phosphorous, nitrate, sulphate, and phosphate, were analyzed. According to WHO standard values, the water was found to be potable. Based on the results of this study, most parameters were within the permissible limits, indicating that the water of Yedgaon reservoir is in good condition. However, for a more comprehensive understanding of the Yedgaon Dam's water quality, we recommend a long-term study that covers all aspects of the water ecosystem.

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