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Assessment of water quality in a dam and downstream river following treatment

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Abstract
The current study investigates the physicochemical characteristics of the surface water at the Sarfa dam in Shahdol, Madhya Pradesh, India, both before and after it has been treated to be made available for human consumption. In accordance with the normal procedures advised by the APHA, water samples obtained from several sites were analyzed for a number of parameters, including pH, electrical conductivity, temperature, TDS, TS.S, T.S, total hardness, calcium hardness, alkalinity, chloride, COD, and BOD. The current study's findings showed that, when compared to treated water, the untreated water had higher physicochemical properties which are detrimental to human health. According to the findings, the water from Sarfa Dam needs to be treated in order for it to be safe for human consumption.

Keywords: Sarfa treated, untreated water, sarfa dam, human consumption, Shahdol city

Introduction

The quality of the raw water that is consumed, the methods employed for treating it, and the network's water monitoring all affect the quality of drinking water that is delivered to the consumer's point of consumption [1-3]. Waterworks must provide safe water that satisfies a set of standards, which are typically broken down into three primary categories: microbiological, chemical, and physical. Water has to be colorless, tasteless, and odorless on the outside. Chemically speaking, the water must be free of heavy metals, organic materials, excess minerals, and hazardous chemicals, and its pH must be between 6.5 and 9.5. It must also be devoid of diseases and radioactive materials [4].

Safe drinking water is supplied to customers in a way that is appropriate for drinking, household usage, and personal hygiene and comes from public water systems, private wells, or bottled water manufacturers [5]. The procedures of screening, chemical addition, coagulation, flocculation, sedimentation, filtration, disinfection, storage, and distribution to consumers are all performed on raw water in public and private water systems [6]. In order to produce safe water in amounts that satisfy community demands and with quality that fulfill regulatory standards, water treatment plants must be equipped with the right procedures and contemporary technologies.

The stability of the water added to the distribution system affects the final quality of the water at the consumer's point of consumption.

A typical water distribution system consists of a complex infrastructure with pumping stations, storage facilities, valves, fire hydrants, service connections, and pipes constructed of different installation materials. It makes sense that keeping an eye on and evaluating the quality of water can be challenging. The materials used to make water supply pipes affect a number of things, including how quickly biofilm forms on the inside surfaces of pipelines and what kinds of chemicals (such corrosion products) are discharged into the water [7, 8, 9]. Water delivery systems nowadays are composed of thermoplastics like polyethylene (PE) and polyvinyl chloride (PVC) to prevent corrosion issues. Plastic pipes exhibit a greater failure rate [10], while also being more vulnerable to the production of biofilms [11]. Another major issue is leaky pipe joints or pipe cracks, which can allow microorganisms that are harmful to customers' health to get into the water. Following repairs, distribution system personnel must then carefully and completely carry out the rinse and disinfection procedure [12].

The stability of the water added to the distribution system affects the final quality of the water at the consumer's point of consumption as well. According to WHO recommendations, water should be microbiologically, chemically, and physically stable. The Langelier saturation index (LSI) and Ryznar stability index (RSI), which forecast calcium carbonate behavior in water, are the most widely utilized techniques for evaluating the chemical stability of water [12,13, 14].

Turbidity values are used to evaluate biological stability [17], whereas carbon, nitrogen, and phosphorus biogenic substances are used to determine physical stability [15, 16]. Microorganism growth depends on these substances. Water instability can have an impact on the quality of the water by allowing certain metals, like lead, arsenic, and chromium, to seep into the water and cause corrosion or bacterial development [18]. It should be kept in mind, though, that creating completely steady water is an extremely challenging process, as it frequently necessitates doing the opposite. For water utilities, finding suitable management techniques to ensure high water quality has never been easy.

The purpose of this study was to ascertain how the quality of tap water changed at particular distribution system locations. A thorough physicochemical examination of the water and the concentration of heavy metals in the tested water samples was done during the monitoring. The primary factor ensuring proper water quality for the customer is the assessment of the physical, chemical, and biological stability of the water.

Materials and Methods

1. Study Area

The primary source of drinking water for Shahdol is Sarfa Dam.The River Sone, a tributary of the Sone River, mixes with the Sarfa River, which has its source in the Pathe Hills, 15 to 16 kilometers from the Sarfa Dam.The Sarfa Dam's width is between 150 and 100 feet, and its deepest point is between 20 and 25 feet. The Sarfa River lies in the northeastern region of Madhya Pradesh, near Shahdol, in latitude 23.2825° N and longitude 81.4692° E. River Sarfa is essential to several villages, including Navalpur, Jamui, Dhurvaar, Kanchanpur, Lalpur, and others, for drinking, agriculture, and other uses.

2. Sampling Point

Since the goal was to evaluate the quality of Shahdol's drinking water supply, water samples were collected early in March from Sarfa Dam in Navalpur**.** The first sample was drawn from dam water, while the second sample was drawn from the Shahdol urban area's water filtration area before it was made available for drinking.

3. Sample Collection

At 8:30 am, a sample of about two liters of water was taken in a sterilized bottle from the depths of Sarfa Dam, and another two liters of water was taken from the location where water is prepared for urban use. Water samples were then delivered to the Madhya Pradesh Pollution Control Board Shahdol for processing or analysis within an hour of this happening.

4. Determination of Physicochemical Parameters

Physical parameters: A digital pH meter was used to measure the temperatures of each sample of tap water (Systronics, 361). and Digital Conductivity Meter (Systronics, 304), respectively, were used to detect turbidity and electrical conductivity. To quantify suspended solids and total solids, a weighing balance (Sartorius, CPA224S Balance) was used.

Chemical Parameters: Using a calibrated pH meter, the pH of the water sample was determined (Digital PH Meter 361, Model No.: 361). Tap water samples were tested for total hardness, calcium hardness, and magnesium hardness using the titration method and an EDTA solution. Volumetric analysis and titration of the water sample with standard H2SO4 utilizing indicator were used to estimate the alkalinity and chloride, respectively. For every tap water sample, the alkali azide method and the dichromate refluction method were used to assess the biochemical oxygen demand (BOD) and chemical oxygen demand (COD), respectively.

Statistical analysis: The average value of each physical and chemical parameters were plotted and analyzed using Graph Pad Prism (6.0 version).

Result

Considerable findings were revealed in our study that showed a significant difference between the water qualities of treated vs untreated water of Sarfa Dam (Figure 1 and Figure 2) (Table 1).

1. pH and temperature: The pH and temperature of both the treated and untreated dam water was found to be similar.

2. Conductivity, Alkalinity and Chloride content: The conductivity and the chloride content of the untreated water were greater than the treated water. The alkalinity of the untreated water was very high while that of treated water appeared negligible.

3. Suspended Solids and Total Solids: The suspended and the total solids were considerably higher in untreated water as compared to the treated water samples.

4. Calcium Hardness, Magnesium Hardness and Total Hardness: The Calcium hardness, Magnesium hardness and Total Hardness were also appeared to be higher in the untreated water than in the treated one.

5. BOD and COD: The BOD and COD were also found to be higher in untreated water as compared to the treated one.

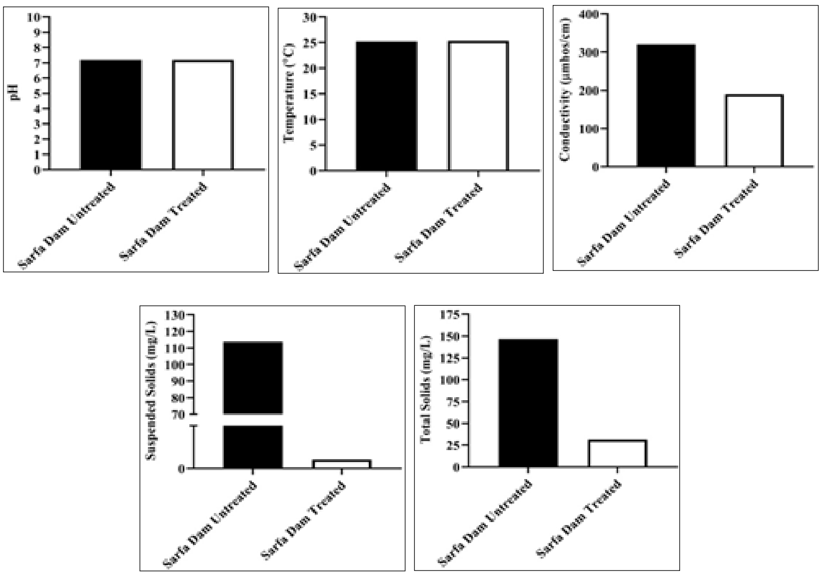

Fig 1: Physicochemical Parameters of Surface Water from Sarfa Dam Before and After Treatment: pH, Electrical Conductivity, Temperature, S.S (Suspended Solids), T.S (Total Solids), Total Hardness, Calcium Hardness, Alkalinity, Chloride, COD (Chemical Oxygen Demand), and BOD (Biological Oxygen Demand)"

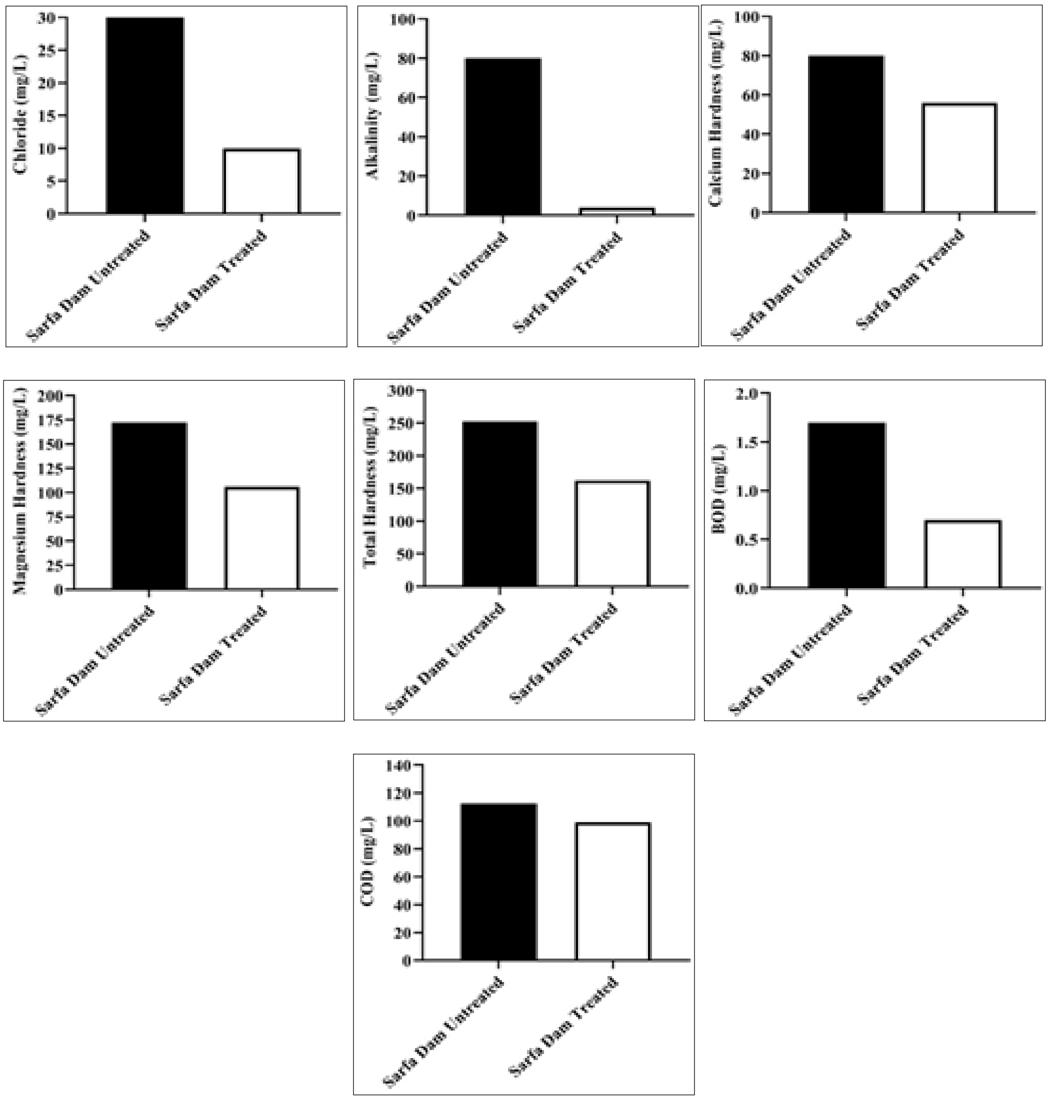

Fig 2: Physicochemical Parameters of Surface Water from Sarfa Dam Before and After Treatment: Alkalinity, Chloride, Total Hardness, Calcium Hardness, Magnesium Hardness, COD (Chemical Oxygen Demand), and BOD (Biological Oxygen Demand)"

Table 1: Physicochemical analysis of Sarfa water untreated and treated

S. No.	Parameters	Sample 1 Sarfa Dam Navalpur normal (untreated) water	Sample 2 Sarfa Dam Navalpur treated water supply for the city
1	pH	7.20	7.20
2	Temperature (°C)	25.20	25.30
3	Chloride (mg/L)	29.99	9.99
4	Alkalinity (mg/L)	80.0	4.00
5	Conductivity (umhos/cm)	320	190
6	Turbidity (mg/L)	3.90	1.40
7	Suspended Solid (mg/L)	113.7	1.00
8	Total Solid (mg/L)	146.5	31.3
9	Calcium Hardness (mg/L)	80	56
10	Magnesium Hardness (mg/L)	172	106
11	Total Hardness (mg/L)	252	162
12	BOD	1.70	0.70
13	COD	112.30	98.88

Discussion

The results of the study show that treated and untreated water from Sarfa Dam differ significantly in terms of quality, highlighting the significance and efficacy of water treatment procedures in guaranteeing the safety of the water for human use. The pH and temperature values of the water samples from Sarfa Dam, both treated and untreated, were comparable. Given that pH and temperature are largely stable and less affected by common water treatment techniques, this consistency shows that the treatment process does not dramatically change these parameters.

In comparison to treated water, the untreated water had higher electrical conductivity and a higher chloride level. Higher ion concentrations, such as those of salts and minerals, which are lowered during the treatment process, are frequently indicated by elevated conductivity. The success of the treatment process in neutralizing basic chemicals is demonstrated by the noticeably increased alkalinity in untreated water, which was negligible in treated water and added to the water's safety and palatability. Untreated water had noticeably greater amounts of total solids (T.S.) and suspended solids (TS.S.). These solids present health problems since they may contain contaminants and germs. The fact that these solids are reduced by treatment emphasizes how crucial it is to remove particle matter in order to increase water clarity and lower the danger of contamination.

The hardness levels of calcium, magnesium, and overall hardness were higher in the untreated water. Hard water is not always the best for cleaning because it can cause scale to build up in appliances and pipes. By reducing the hardness of the water through treatment, the water becomes safer to drink and more appropriate for use in industry and the home. Increased levels of contaminants and organic matter are indicated by higher Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) values in untreated water. A major hazard to aquatic life is elevated BOD levels, which can cause stress, asphyxiation, and death in organisms as a result of oxygen deprivation [19], and elevated COD values may be related to increased chemical contaminants [20].

These factors are essential for figuring out how much organic pollution there is in the water and whether or not it can support microbial life. After treatment, there was a noticeable decrease in BOD and COD, indicating that organic pollutants were removed, an important step in preventing waterborne illnesses and safeguarding public health.

Conclusion

The study's findings support the need for and effectiveness of water treatment techniques in raising the standard of water from Sarfa Dam. The important reduction in suspended and total solids, hardness, BOD, COD, conductivity, alkalinity, chloride concentration, in treated water show how important treatment is to making the water safe to drink. These results validate the need for strict and ongoing implementation of water treatment protocols to protect public health and guarantee that Shahdol inhabitants have access to clean, drinkable water. It is advised to regularly monitor and analyze these physicochemical parameters in order to maintain and raise water quality standards, which will ultimately benefit the community's health and well-being.

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Conflicts of Interest

The authors declare no conflict of interest.

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