Study of quality of drinking water of S.N.Puram locality of Cherthala, Kerala,India in terms of biochemical oxygen demand

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Abstract: Biochemical Oxygen demand is an important parameter for assessing the quality of water. This study was carried out by collecting water samples from various water sources of S.N.puram locality of Cherthala,Kerala. Dissolved oxygen content of the sample immediately after collection and after incubation for five days at 20^0c was determined using Wrinklers method. From these two values BOD was determined

Key words: Biochemical oxygen demand, Dissolved oxygen, Wrinkler's method

1.Introduction

Water is one of the most important substance on earth. All living beings both plants and animals need water for their survival. It's use cannot be substituted by any other substance. The quality parameter of water depends on its purpose of use. Water that is suitable for irrigation may not be suitable for drinking purpose. In India there are two water sources, surface water and ground water. Eventhough there is plenty of water on earth, only a small portion of it is suitable for drinking [1]. Fresh water for future generation is a global concern, due to natural and human activities. Water that can be consumed without any health risk [2] is termed as drinking water or portable water. Good quality drinking water is one of the basic requirement of life. It is an indication of standard of living. Those who have no accesses to safe drinking water is vulnerable to many serious disease.

One of the key parameters used to evaluate water quality is Biochemical Oxygen Demand (BOD), which indicates the amount of oxygen required by microorganisms to decompose organic matter in water. High BOD levels in drinking water often reflect pollution and the presence of organic contaminants[3] that could compromise water safety and human health. In this work, we focus on estimating the BOD of drinking water samples. BOD is a vital indicator of the biological activity and the extent of contamination in water[4]. Accurate determination of BOD helps in assessing the health of water sources and ensuring that drinking water meets the required standards for consumption. The primary goal of this work is to, analyse drinking water samples for organic pollutants, and interpret the results to determine the water's suitability for consumption. By conducting these tests, we aim to highlight the significance of BOD in maintaining water quality and the role of monitoring in public health protection.

2.Materials and methods

2.1.Chemicals

All chemicals were of analytical grade and used without further purification.

Sodium Thiosulphate (A.R grade, Merck), Potassium Dichromate (A.R grade, Merck), Manganese Sulfate dehydrate (A.R grade, Merck), Potassium Hydroxide (A.R grade, Merck), Concentrated Sulphuric Acid (Nice Chemicals), Potassium Iodide (A.R grade Sigma Aldrich) and Starch (A.R grade, Merck).

2.2. Reagents

1. Alkali – Iodide reagent

To prepare this reagent, 70 g of Potassium hydroxide and 15 g of potassium iodide were dissolved in distilled water, and made up to 100 mL.

2.3. METHOD

Wrinkler's Method

Principle

The Wrinkler's (iodometric) method [5] depends on the fact that oxygen oxidize Mn^{2+} to a higher state of valence under alkaline conditions. In higher states of valence,it is capable of oxidizing iodide ions to free iodine under acidic conditions[11]. The free iodine thus released is equivalent to the dissolved oxygen originally present in the sample and is measured by titration with standard sodium thiosulphate solution in the presence of starch as indicator.

When $MnSO_4$ and alkali-iodide (KOH + KI) reagent are added to a sample in which no DO is present, a white precipitate of $Mn(OH)_2$ is formed. If dissolved oxygen is present, it oxidizes some of the Mn^{2+} ion to Mn^{4+} ions, forming MnO_2 floc, as follows:

$$Mn^{2+} + 2OH^{-} \rightarrow Mn(OH)_2 \text{ (under zero DO conditions)} \quad (1)$$

$$Mn^{2+} + 2OH^{-} + \tfrac{1}{2} O_2 \rightarrow MnO_2 + H_2O \quad (2)$$

$$Mn(OH)_2 + \tfrac{1}{2} O_2 \rightarrow MnO_2 + H_2O \quad (3)$$

(In the presence of DO in the sample)

The amount of Mn^{2+} ions thus oxidized depends on the amount of dissolved oxygen present in the sample. The MnO_2 floc on acidification with H_2SO_4 oxidizes iodide ions to free iodine:

$$MnO_2 + 2I^- + 4H^+ \rightarrow Mn^{2+} + I_2 + 2H_2O \qquad (4)$$

The resulting free iodine is measured by titrating against sodium thiosulfate in the presence of starch as indicator:

$$2Na_2S_2O_3.5H_2O + I_2 \rightarrow Na_2S_4O_6 + 2NaI + 10H_2O \qquad (5)$$

Or

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^- \qquad (6)$$

When starch solution is added to the sample, the free iodine gets adsorbed on the surface of the colloidal starch particles and gives a blue colour to the solution. During titration the free iodine is desorbed from the starch particles and is converted to iodide. When all the iodine is desorbed and converted to iodide, the blue colour disappears. The disappearance of blue colour of the solution is identified as the end-point.

1. Preparation of standard $K_2Cr_2O_7$

For preparing standard dichromate solution 0.48 g $K_2Cr_2O_7$ is accurately weighed and made up to 1L, shaken well for uniform concentration.

2. Standardization of Sodium Thiosulfate

20 ml of standard potassium dichromate solution is pipetted out in to a conical flask; 4 ml of concentrated H_2SO_4 followed by 10 ml potassium iodide solution is added. The solution is titrated against sodium thiosulfate solution from the burette using starch as indicator until the blue colour changes to green.

3 . Estimation of dissolved Oxygen (Wrinkler's method)

50 ml water sample collected into a BOD – bottle and made up to 250ml.It is then treated with 2 ml $MnSO_4$ solution and 2 ml alkali – iodide reagent. Stopper the bottle avoiding air bubbles and mix the contents by inverting the bottle for at least 15 times. Allow the contents to settle. After half of the contents of the bottle become clear of the manganese hydroxide flocs, shake once again and allow resettling for 2 minutes or more till at least 100 ml of clear supernatant is produced. Quickly add 1 ml concentrated H_2SO_4, allowing the acid to run down the neck of the bottle. Restopper the bottle and mix by gentle inversion until all the manganese hydroxide flocs gets dissolved. Ensure that the liberated iodine is uniformly distributed throughout the bottle before the sample is pipetted for the next step.

Pipette 100 ml of the sample into a conical flask and add a few drops of starch solution. Titrate against standard $Na_2S_2O_3$ solution taken in a burette. Note down the quantity (in ml) of $Na_2S_2O_3$ rundown to obtain the end-point. Complete disappearance of blue colour is considered as the end point of titration.

2.4. Determination of BOD

Take two BOD bottles of 250ml. A sample of 50ml was pipetted into each of the two 250 ml BOD bottle and diluted to volume using distilled water. The DO content of one of the sample is determined immediately using Wrinklers method and recorded. The other sample bottles is incubated in the BOD incubator for five days at 20°C. At the end of five days, the final DO content is determined and the difference between the final DO reading and the initial DO reading is calculated. The decrease in DO is corrected for sample dilution, and represents the biochemical oxygen demand of the sample. BOD of samples from different sources are determined as above.

3.Results and discussion

The Wrinkler's method is a well accepted method for determining dissolved oxygen content (DO) of water samples. The measurement of initial and final disolved oxygen content enables us to calculate biochemical oxygen demand (BOD) according to the equation

BOD = (Initial D.O- Final D.O.)/ P

Where P is the dilution factor

Considering the significance of BOD as a water quality parameter this study was carried out to assess the quality of drinking water in S.N. puram locality of Cherthala,Alappuzha of Kerala. For this study we selected five different water sample from various source,pond water,stream water,borewell water,well water and rain water

Wrinkler's Method is based on the oxidizing property of dissolved oxygen. The free I_2 liberated during the titration is equivalent to dissolved oxygen present originally in the sample. By titrating a water sample against standardized sodium Thiosulphate, normality of oxygen can be calculated using the equation $N_1V_1=N_2V_2$. Knowing the normality of oxygen mass per liter of oxygen or dissolved oxygen can be calculated. From our studies we got an idea about the quality of drinking water selected. By measuring the initial and final DO, BOD can be calculated.

No.	Name	Source	Initial DO	Final DO	BOD (mg/l)
1.	Sanple 1	Pond	12.917	10.688	11.148
2.	Sample 2	Stream	9.354	8.312	5.211
3.	Sample 3	Bore well	13.5116	12.84	3.358
4.	Sample 4	Well	10.096	9.056	5.2
5.	Sample 5	Rain water	10.393	10.24	0.768

Table 1 Amount of DO and BOD in various water samples

The pond sample shows the highest BOD and the largest drop in DO, indicating it may contain organic matter such as decaying plant material or algae that supports microbial growth. The stream and well samples have moderate BOD levels, reflecting some organic contamination but not to the same extent as the Pond. The bore well sample has a low BOD, which could indicate a relatively low level of organic matter, possibly due to the protected and isolated nature of groundwater. Rain water has the lowest BOD value as expected due to the presence of fewer contaminants and organic matter.Due to low BOD value bore well water and rain water can be recommended for drinking purpose. High BOD value of pond, stream and well water is an indication that they are vulnerable to oxygen depletion and also unfit for drinking purpose.

4Conclusion

The aim of the present study was to get a comparative assessment of suitability of various water sources available in S.N. puram area of Cherthala, kerala for drinking purpose.The study was carried out by determining biochemical oxygen demand by Wrinklers method.The study showed that rainwater obtained by rain water harvesting had a very low BOD value and most suitable for drinking purpose.Borewell water has also a BOD value of 3.358mg/l which falls in the range of good water fit for drinking.But stream water,well water and pond water has high

BOD value which makes it unfit for drinking purpose.Managing organic pollution and preventing excessive run off of nutrients into waterbodies is crucial in maintaining water quality and preventing environmental degradation.

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