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A COMPREHENSIVE STUDY ON THE BIOCHEMICAL PROFILE OF WATER QUALITY INDICES FROM VARIOUS RESOURCES

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Abstract

Water is an essential innate resource on earth. All life including human being depends on water. Water resources are of great significance to human life and wealth and are the main insistence for the demand of drinking water, for irrigation of lands and industries. However, the pollution of the sampling area in this research is mainly from domestic pollution, which consists of some fixed pollutants, and the initial concentration of the pollutant does not fluctuate significantly. In practical applications, diverse pollution occurs, such as urban non-point source pollution, irrigation backwater pollution, livestock breeding pollution and garbage pollution. Water quality index uses variables such as dissolved oxygen, biochemical oxygen demand, acidity, alkalinity, chemical oxygen demand and chloride content, the index similarity are used to assess the water quality conditions.
Keywords: water quality index, dissolved oxygen, BOD, water pollution, water quality management

I. INTRODUCTION

Water resources are significant to both society and ecosystems. We depend on a consistent, hygienic contribution of drinking water to maintain our health. We also require water for agriculture, energy manufacturing and recreation [1]. Water pollution and its impacts on the surroundings are severe issues for present earth. Pollution of urban rivers has become increasingly problematic in recent years [2], and organic pollution is an important type of urban river pollution [3].To limit the water contamination and recover the water quality, sophisticated wastewater treatment technologies are discovered. Heavy rainfall produces more pollution and sedimentation in river due to surface runoff. Anthropogenic activities, such as release of waste from house hold, plastic equipments, disposal of car batteries, unprocessed waste from sewage treatment plants, mining actions are worsening the water quality of rivers [4]. Hydraulic conditions have a significant impact on dispersion and reaeration within a river [5]. The water quality problems affecting the Bagmati River include low dissolved oxygen concentrations, bacterial contamination, and metal toxicity [6]. To minimize the potential risks from untreated wastewater entering freshwater resources, industrial wastewater plants go through a water quality assessment by monitoring some parameters. Evaluation of quality of river water using a variety of parameters physico-chemical and biological and techniques to guard the river water have been reported in the literature [7]. Estimation of the environmental water quality index is a newly proposed index by [8] which is designed by multiplying the absorption of each contaminant calculated in the water samples with the equivalent hazard intensity to decide the water quality impact. The hazard concentration of each parameter was decided according to the total score assigned by the Toxicological Profiles of the main concern list of harmful Substances prepared by the Agency for Toxic Substances and Disease Registry (ATSDR), the Division of Toxicology and Environmental Medicine, Atlanta, USA [9].These alterations can promote countless changes in the availability of water and the health of the human population [10,11]. Prior reports have shown encouraging results in the improvement of water quality due to proper management policy and remedial measures [12]. This study was aimed to investigate the acidity, alkalinity, oxygen, biochemical oxygen demand and chloride content in the rivers of siruvani, vaigai, pond water and other drinking water samples

II. MATERIALS AND METHODS

Water samples were collected form rivers of siruvani, vaigai, garden pond water, drinking water and tap water. The parameters such as acidity, alkalinity, oxygen, biochemical oxygen demand, chemical oxygen demand, chloride content were estimated by APHA methods[13].

2.1 Determination of acidity in water samples

25 mL of sample is pipette into conical flask. If free residual chlorine is present, 0.05 mL (1 drop) of 0.1 N thiosulphate solution is added. 2 drops of methyl orange indicator is added. These contents are titrated against 0.02 N hydroxide solution. The end point is noted when colour change from orange red to yellow. Then two drops of phenolphthalein indicator is added and titration continued till a pink colour just develops. The volumes of the titrant used are noted down.

2.2 Determination of Alkalinity in water samples

The total alkalinity of the water sample is due to the carbonate and bicarbonate present. Take 50 ml of sample and add 5 drops of phenolphthalein indicator. If there is formation of pink color due to the presence of bicarbonate titrate it against 0.02N sulphuric acid until the pink colour disappears. If there is no pink colour formation add 2 drops of methyl orange to another 50ml of the sample and proceed the titration until the orange colour of methyl orange turns into pinkish orange.

2.3 Estimation of Oxygen

In a highly alkaline conditions manganese hydroxide is oxidized and on acidification in the presence of iodide, the manganous hydroxide dissolves and free iodine liberated in an amount equal to the oxygen originally dissolved in the sample. The iodine is treated with a standard sodium thiosulphate using starch as indicator. Add 2 ml of $MnSO_4$ followed by 2 ml of alkaline iodide reagent well below the surface of the liquid in the sample bottle. Allow the precipitate to settle and dissolve it by adding 2 ml of concentrated H_2SO_4. Take 50 ml of the sample and titrate it against 0.25N sodium thiosulphate using starch as indicator. The end point is the disappearance of blue colour.

Standardisation of $Na_2S_2O_3$

Take 20 ml of $K_2Cr_2O_7$ in a conical flask and add 10 ml of KI solution and 5 ml of H_2SO_4. Take the $Na_2S_2O_3$ solution and proceed with titration. When the solution acquires yellowish green colour add 1ml of starch solution. Titrate further till the greenish blue shade changes to yellowish green.

2.4 Determination of biochemical oxygen demand of water

Biochemical oxygen demand of the sample is measured as the quantity of dissolved oxygen required to effect stabilization of aerobic bacterial action of the portion of the dissolved organic matter which could be oxidized in five days at 20°C in dark.

Dilution water

Distilled water of good quality, free from metals particularly copper and aerated at 27°C. In water samples where more than 70% of the initial oxygen is consumed, it is necessary to aerate or dilute the sample with BOD free water to avoid oxygen stress.

Procedure

Adjust the temperature of a suitable portion of the well- mixed sample (diluted and undiluted) to 20°C. Fill completely two glass stoppered bottles with the sample. Adjust the pH of the sample to neutrality using 1N acid or 1N alkali. Allow to stand for 15 min to avoid air bubble and determine the dissolved oxygen in one bottle immediately. Keep the other bottle in dark in BOD incubator for 5 days at 200° C and thereafter determine the dissolved oxygen. Run the blank simultaneously without adding the sample.

2.5 Determination of chemical oxygen demand of water

COD is used to calculate the oxygen equivalent of the natural matter content of a test that is sensitive to oxidation by a chemical oxidant. The amount of organic matter in water is estimated by its oxidability by chemical oxidant such as potassium permanganate or potassium dichromate.

Procedure

Take 10 ml of water sample in duplicates. Add 15 ml of potassium dichromate solution, a pinch of $HgSO_4$ and 10ml of concentrated H_2SO_4 to each of the flasks. Reflux the sample in a water bath for 1-2 hours. Simultaneously run a blank in duplicates. Cool and add 2 to 3 drops of ferroin indicator. Titrate the sample against ferrous ammonium sulphate solution. End point is indicated by sharp colour change from blue green to reddish brown.

$$\text{COD of sample mg/litre} = \frac{(A-B)\times N\times 8000}{\text{ml of sample}}$$

A is Ferrous ammonium sulphate used for blank (ml); B is FAS used for sample
N is Normality of FAS

2.6 Measurement of chloride

The chloride present in water sample is treated with silver nitrate solution.

$$Cl^{-} + Ag^{+} \longrightarrow AgCl$$

Potassium chromate is used as indicator. At the end point, the concentration of chloride ion in solution when reaches zero, the silver ion concentration increases to a level at which the solubility product of silver chromate exceeds. Then silver chromate is precipitated as a reddish brown product.

$$2\,Ag^{+} + CrO_4- \longrightarrow Ag_2CrO_4$$

Procedure

Pipette 50/10 ml of the water sample into a conical flask. Pipette into it 0.5 ml/drop of $K_2Cr_2O_4$ indicator. This gives yellow colour to the sample. Titrate the solution with shaking conditions against standard silver nitrate solution till the appearance of reddish brown colour. Perform a duplicate titration in an identical manner. Carry out a blank titration using 50 ml of deionized, chloride free water and 0.5ml of the indicator. Substract this titre value from that obtained for the water sample.

Table: 1 Determination of Acidity in water samples

Titration of given water sample against 0.0227N sodium hydroxide

Sources of water sample	Volume of sample(ml)	Burette reading (ml)		Volume of NaoH(ml)	Indicator concentration of CO_2 (ppm)
		Initial	final		
Tap water	100	0	8.81	8.81	88
Drinking water	100	0	0.7	0.7	7
Garden pond water	100	0	4.6	4.6	47
Vaigai river	100	0	5.2	5.2	52
Siruvani river	100	0	4.3	4.3	43

III. RESULTS AND DISCUSSION

Rivers and lakes are the most studied environments, as these are the environments where freshwater is more accessible for population [14]. Acidity of water samples were represented in Table: 1. Preceeding studies stated that based on the WQI results most of the samples are falling under admirable to superior quality and suitable for drinking water [15]. Acidity is used to calculate and infer the only when the chemical substance of the sample is identified [16,17]. Acidity is classified by the pH value of a titration end point. Acidity caused by mineral acids contains a pH below 4.5[18] The value was found to be higher in tap water possessing a concentration of 88 ppm, whereas garden pond water acquired an moderate value of 47 ppm, the level of acidity was found to be 7 ppm in drinking water. The index similarly indicates poorer water quality conditions in Jan and Mar 2016, with stations 16–18 (near industrial area and barrage) corresponding to lower index values The quantity and quality of river water, particularly during the dry season, is at very alarming [19,20].

Table: 2 Determination of Alkalinity in water samples
Titration of water samples against 0.02 N H_2SO_4

S.No	Source of water sample	Volume of water sample	Burette reading		Volume of H_2SO_4 used in sample	Akalinity per litre		% of alkalinity	
			Initial in ml	Final in ml		carbonate	bicarbonate	carbonate	bicarbonate
1.	Siruvani river	50	0	0.7	0.7	14	14	11.4	1.4
2.	Garden pond water	50	0	21.8	21.8	436	-	43.6	-
3.	Vaigai river	50	0	7.2	7.2	144	-	14.4	-
4.	Tap water	50	0	27	27	540	-	54	-
5.	Drinking water	50	0	6	6	7.3	-	12	-

Water Quality index has been used by researchers to check water quality status of rivers flowing in different parts of India. Alkalinity of water samples were depicted in Table: 2. The experimental water bodies recorded approximately neutral or slightly alkaline in nature (Bouslah et al. 2017). In the existing study tap water possess elevated levels of carbonate(540mg/l), whereas the values were found be be lower in siruvani river(14mg/l) [21]. Vaigai river acquired moderate levels of carbonate about (144 mg/l). In previous studies water quality evaluation of Kolong River, Assam, where the water samples showed a decline in pollution trend further downstream [22]. Effendi et al. (2015), grab surface water samples from 12 locations were collected, processed and analyzed for 11 pre-identified variables [23]. Another report of water quality index usage stated that based on the WQI results majority of the samples are falling under excellent to good category and suitable for drinking water [24].

Table: 3 Estimation of oxygen

S.no	Water Sample	Volume of Sodium thiosulphate		Volume of sample taken (ml)	Amount of oxygen dissolved
		Initial (ml)	Final (ml)		
1.	Vaigai river	0	0.1	50	Undiluted
2.	Garden pond water	0	0.2	50	75%
3.	Siruvani river	0	11	50	25%
4.	Tap water	0	0.2	50	50%
5.	Drinking water	0	7	50	32%

Estimation of oxygen was represented in Table: 3. Oxygen gas dissolves freely in fresh waters. Its presence in surface water plays a key role in the self-purification and maintenance of aquatic life [25]. In the existing study garden water acquires 75% of oxygen, while possessing a minimum range of 25% in siruvani river. Oxygen is produced from the atmosphere and by photosynthesis from aquatic plants and is utilized by many respiratory biochemical, as well as by inorganic chemical, reactions. The river water provides an appropriate environment for the metabolism of microbes [26]. The quantity and quality of river water, predominantly during the dehydrated season, is at very disturbing levels. In previous report the concentrations of DO (oxygen diluted in water) was satisfactory-within 4.48- 9.48 mg/l [27].

Table: 4 Biochemical oxygen demand of water

S.no	Sources of water sample	Volume of initial(ml)	$Na_2S_2O_3$ final in ml	Volume of sample taken in ml	Concentration
1.	Vaigai river	0	1.7	50	Undiluted
2.	Garden pond water	0	0.2	50	75%
3.	Siruvani river	0	11	50	28%
4.	Tap water	0	0.2	50	50%
5.	Drinking water	0	0.1	50	72%

BOD is similar in function to COD in that both measure the amount of organic compounds in water [28]. Biochemical oxygen demand of water were depicted in Table: 4. During 5 days of incubation at 20°C and is often used as a surrogate for the degree of organic pollution of water (Armiento, 2016) [29]. In prior studies groundwater was mostly found to be polluted near the urbanized and industrialized areas of Pune, Mumbai, Thane, Chandrapur, and Solapur which were lying in low rainfall area [30]. In present study the BOD content was found to be 75% in garden pond water, whereas siruvani river possess least concentration of 28%. It is an important indication of the organic substance in water and it reflects the situation of the water pollution [4]. In prior studies an algorithm is programmed to simulate a total of 100 samples with BOD < 1.0mg/L [31]. The calculation of biological indicators to the accessible index as microbial pollution is a prevalent concern in rivers of Malaysia due to the temperate and moist tropical climate, favorable for microbial growth [32, 33]. Previous study utilized an oxidation ditch treatment process with a nitrification/denitrification unit resulting in removal efficiencies of 95% for biological oxygen demand (BOD) and 80% for total [34].

Table: 5 Chemical oxygen demand of water

S.no	Volume of H_2O sample	Burette reading		Volume of titrant used in ml
		Initial in ml	Final in ml	
1.	Vaigai river	0	17.2	17.2
2.	Siruvani river	0	13.2	13.2
3.	Drinking water	0	15.9	15.9
4.	Tap water	0	15.8	15.8
5.	Pond water	0	17.5	17.5

Chemical oxygen demand of water were represented in Table: 5. Although the hydraulic conditions are important factors affecting the degradation coefficient, the reduction of the amount of COD concentration in the annular flume is a direct reflection of the biochemical reaction [35]. In the present study the COD content in pond water was found to be higher (17.5 mg/ml), whereas moderate in tap water comprising of 15.8 mg/ml. Siruvani river acquired lower level (13.2 mg/ml) of COD compared to other water samples Studied the feasibility of using the information of ultraviolet spectrum and near infrared spectroscopy to predict the COD content in wastewater, and established the COD prediction model of waste water [36]. The exchange of nutrients in the river can promote the metabolism of microorganisms [37], resulting in rapid COD degradation in rivers

Table: 6 Measurement of chloride

S.no	Source	Burette reading		Volume of titrant used in ml	Chlorine content (mg/l)
		Initial in ml	Final in ml		
1.	Garden pond water	0	12.5	12.5	459.98
2.	Tap water	0	18	18	734.97
3.	Drinking water	0	6	6	229.9
4.	Vaigai river	0	25	25	918.2
5.	Siruvani river	0	32	32	1399

Measurement of chloride were depicted in Table: 6. Chloride occurs naturally in all types of water; however, its main contributing sources are runoff of inorganic fertilizers from agricultural fields, sewage discharge, etc. In preceeding reports the chloride content of the sample was found to be well within the permissible levels of 250 mg/l. Once chloride is dissolved in water, it generally travels with the water without reacting with other solutes or sediments. In existing study the siruvani river possess maximum chlorine level of 1399 mg/l. Drinking water possess minimum chlorine content of 229.9 mg/l. Chloride concentrations are increasing in surface water and groundwater in many parts of the United States [38]. The only practical ways to remove it from the water are through ion exchange, reverse osmosis, or distillation. The supply of trace metal pollutants do not have straight contact on the visual properties of water, but, their existence influences the storage and space properties of water, viz., pH, total dissolved solid and turbidity [39].

IV. CONCLUSION

This preliminary rapid water quality evaluation must be followed by expected water quality monitoring of the water resources which is essential to evaluate the quality of water for ecological strength.

V. CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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