DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS AND STUDY OF SOME HEAVY METALS AND ITS EFFECTS OF FOOD WASTE WATER OF RAIPUR

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ABSTRACT: ***Food waste water samples were collected from restaurants of renowned hotels of Jaistambh square (chowk) area in Raipur. Samples were collected between the periods of July 2017 to December 2017 to determine the following parameters, pH, temperature, turbidity, chemical oxygen demand (COD, Biological oxygen demand (BOD), Dissolved oxygen (DO), Conductivity, Total dissolved solid (TDS), Total suspended solid (TSS), Alkalinity, Iron, Sulphate, Nitrate and Phosphate, copper, lead, nickel and zinc. Levels of pH, conductivity, temperature, TSS, TDS, DO, BOD and COD were found as per the limits except certain variations. The heavy metals concentration was determined analytically and spectrophotometeric analysis was performed and correlated and compared the results with WHO. The physicochemical parameters of food waste water samples reveal that the waste water used for irrigation and farming of nearby areas is considerably polluted and not suitable for aquatic organisms, irrigation and agricultural purposes. The objective of this research is to determine the levels of some physicochemical parameters and study of heavy metals and its effects on human and environment of food waste water of Raipur.***

Keywords: Food waste water, physico-chemical parameters, pollutants

1. INTRODUCTION

In the present global scenario, due to improper management of huge amount of waste water generated by various sources such as restaurants, bakeries, hotels, canteens, confectioneries and the quality of water used by restaurants, hotels and various food vending sites, are discharging various levels of pollutants knowingly or unknowingly into the environment directly or indirectly through public sewer lines, dumping yards and reservoirs which are directly connected from restaurants and other commercial sites. Wastewater samples were collected from the Jaistambh square of Raipur city situated in state of Chhattisgarh. Sampling was done from July 2017 to December 2017. The laboratory test of the collected water samples were performed for analysis of various parameters such as pH, temperature, turbidity, chemical oxygen demand (COD), biological oxygen demand (BOD), dissolved oxygen(DO), conductivity, total dissolved solids (TDS), total suspended solid (TSS), Alkalinity, Iron, Sulphate, Nitrate and Phosphate. Amongst the heavy metals determination study of copper, lead, nickel and Zinc was performed. The obtained values are compared with the standard limits. The results of this study reveal that the physico-chemical parameters are falling under acceptable category except slight variations in some parameters and concentration of some heavy metals are found below detectable limit except zinc at sites beyond the maximum permissible limit of municipal authorities and WHO guidelines. Hence, the food waste water around the Raipur (Jaistambh) area of is discharging the pollutants considerably, than the acceptable category of WHO and municipal authorities. Although, the assessment of physicochemical parameters of the effluents indicates that some of the hotels and restaurants conform to the recommended guidelines of various authorities, however exceptions occur in the total dissolved solids (TDS) and metal contents The objective of this research is to determine the levels of some physicochemical parameters and study of heavy metals concentration & its effects on human and environment of food waste water of Raipur. The study of waste water samples reveals that the wastewater used for the irrigation and agricultural purposes of these nearby areas can be considered as polluted and thus not suitable for agricultural purposes. Thus, the food waste water around the Raipur city is remarkably polluted. Domestic, kitchen wastes and commercial food processing waste water generated due to either improper supply or addition of some chemicals, adulterated foods or water supply through corroded pipelines should be properly disposed. Increasing global concern on the environment demands that waste water should be properly treated in order to minimize and possibly eliminate their potential harm to public health and the environment.

2. STUDY AREA

Jaistambh chowk is one of the major commercialized sites located in Raipur city area of District Raipur in Chhattisgarh State, India. Raipur is situated at 21.25º N 81.63ºE the height of sea level 298.5 meter. Jaistambh chowk is located in city centre, main market area where foot fall is very high. The selection of site is owing to many number of hotels, restaurants, confectioneries are situated where outflow of waste water and quality is of prime concern.

3. STATEMENT OF THE RESEARCH PROBLEM

Farmers in nearby Raipur city continuously use waste water for irrigation farming directly or indirectly. They also apply sludge waste for the purpose of raising soil fertility at various places. Human beings have succeeded in poisoning themselves with immeasurable amount of polluted

water and heavy metals for over a long period of time (Kate, 2006). The technological advancement has its negative consequences towards humanity. (Ferner, 2001), reported that heavy metal toxicity result in significant illness and reduces the life of human beings and other creatures. Therefore, there is need to determine and express various level of toxic substance in the wastewater sample and in farm produce etc. Adomoroti (1982).

4. JUSTIFICATION OF THE RESEARCH

There is a serious concern with the regard to increase in population of humans, animals and biodiversity in urban cities which is not commensurably challenged with the supply of good quality water. Concerned authorities cannot constantly and adequately supply good quality water that will take care of domestic and irrigation activities. The use of wastewater for irrigation farming activities is considered as illegal activities that not only pose dangers to Man but also Material and environment. Governing agencies, social welfare, sanitary services and NGO's are stepping forward to overcome the problem but all efforts prove to be in vain, unless the root cause evil is eliminated. But the demand and supply ratio is totally disturbed with outdated technology; hence need to overcome the problem with cost effectiveness, efficient and ecofriendly procedures are need to be developed without posing side effects.

5. NATURE AND CHARACTERISTICS OF EFFLUENTS

Food waste water are found in hotels, canteens, bakeries and various commercial sources, as a result of used foods or washing of utensils where food is left out. The water which is being supplied to the hotels and the quality of water which is being used poses serious threat to the man, material and environment. Food waste water contains suspended solids, both biodegradable and non biodegradable organics: oils and fats; heavy metals and dissolved inorganic; acids, bases and coloring compounds. Food wastes excreted from commercial sources such as hotels and restaurants contains high content of oils and greases which poses serious threat to aquatic organisms. It is observed that the pH analysis of effluents from food waste water discharged into sites tends to be normally very acidic.

6. MATERIALS AND METHOD

6.1 SAMPLING AREA AND SAMPLING POINT

Food waste water samples were collected from kitchen drains of different renowned hotels and restaurants of Raipur area (Jaistambh chowk) for the analysis of physicochemical parameters. Measurement points for the sampling were designated as R1 to R5. Wastewater samples were collected at the discharge point from Jaistambh chowk designated as R5; 300metres away from it at Sharda Chowk (R4); and at 700 meters towards Maudhapara (R3) and towards Railway station (Fafadih) samples were taken from two different hotels designated as (R2) and (R1) respectively. Food waste water was sampled at these points.

6.2 SAMPLE COLLECTION

The waste water samples were collected from the selected five locations (R1-R5) at discharge pit unit or through drains of the hotels and restaurants designated from R1 to R5 in hard glass bottles which has been thoroughly pre cleaned with non ionic detergent rinsed with tap water and after some time soaked in 10% HNO_3 and lastly with distilled water .The samples were collected differently for multiple tests. Ademoroti (1996). The samples were labeled and transported to the laboratory, stored in the refrigerator at about 4°C prior to analysis. The wastewater sample used for DO and BOD determinations were collected directly into dark DO bottles and were added some drops of manganous sulphate solution to fix the dissolve oxygen. After collection it was stored at room temperature.

7. METHODS OF ANALYSIS

The source for the collection of waste water samples throughout the studies was the kitchen drain of various restaurants. Observations and findings were continuously recorded for the assessment of parameters like pH, temperature, turbidity, conductivity, TDS, TSS, BOD, COD, DO, Iron, Sulphate, Nitrate and Phosphate to assess the nature of extent of pollution. Those parameters such as Total Dissolved Solid (TDS), Bio-chemical Oxygen Demand, Iron, Sulphate, Nitrate and Phosphate were analyzed as per the standard guidelines and procedures as described in the Standard Methods from the Guide Manual and Waste water analysis as per CPCB and other reference sources. N. Manivasakam (2011). Determination of heavy metals concentration was performed analytically and compared with digital spectrophotometeric analysis. Where immediate analysis was not possible, samples were preserved to inhibit biodegradation. All the reagents used for the analysis were of analytical grade and obtained from Merck and Qualigens Brand.

7.1 DETERMINATION OF PHYSICOCHEMICAL POLLUTANT PARAMETERS

The analysis of various physico-chemical parameters namely pH, temperature, turbidity, chemical oxygen demand (COD, Biological oxygen demand (BOD), dissolved oxygen (DO), conductivity, total dissolved solid (TDS), total suspended solid (TSS), Total Alkalinity, sulphate, nitrate, nitrite and phosphate and heavy metal concentrations were carried out as per the method described in APHA (1992) and Guide Manual N.Manivasakam (2011).The instruments used were in the limit of precised accuracy. The chemicals used were of AR grade. Utmost care was taken during sampling to avoid any kind of contamination. Temperature and pH were measured at the time of sampling itself. All field meters and equipment were checked and calibrated according to the manufacturer's specifications. The pH meter was calibrated using buffers of pH 4.0, 7.0 and 10.0 & dissolved oxygen Dissolved oxygen was measured with DO meter. (DO) meter was calibrated prior to measurement with the appropriate traceable calibration solution (5%HCl) in accordance with the manufacturer's instruction. Biswas et al (2015). The spectrophotometers for anions determination were checked for malfunctioning by passing standard solutions of all the parameters to be measured; Blank samples (deionized water) were passed between every three measurements of wastewater samples to check for any eventual contamination or abnormal response of equipment. Standard methods were followed in determining the above variables. In-situ measurements for some of the parameters, pH and temperature (°C) were measured using pH electrode and thermometer. Conductivity and TDS meter was used to measure the conductivity and total dissolved solids of the water samples. Levels of turbidity and total suspended solid of the wastewater samples were determined using standard procedures. HACH (1997). The biological oxygen demand determination of the wastewater samples in mg/L was carried out using standard methods described in guide manual. APHA (1995).The dissolved oxygen content was determined before

and after incubation. Sample incubation was for 5 days at 20ºC in BOD bottle and physicochemical determination of pollutants in food waste water was calculated after the incubation periods. Determination of chemical oxygen demand was carried out using Liebig condenser with 300 mm jacket. Sulphate test was performed gravimetrically and compared with spectrophotometer analysis. Nitrate and phosphate tests were performed volumetrically and spectrophotometer analysis was done. Heavy metals concentration was determined analytically and spectrophotometrically APHA (1998) and its results were correlated and compared with WHO and municipal authorities limit

7.2 DIGESTION OF WASTEWATER SAMPLES FOR HEAVY METALS DETERMINATION

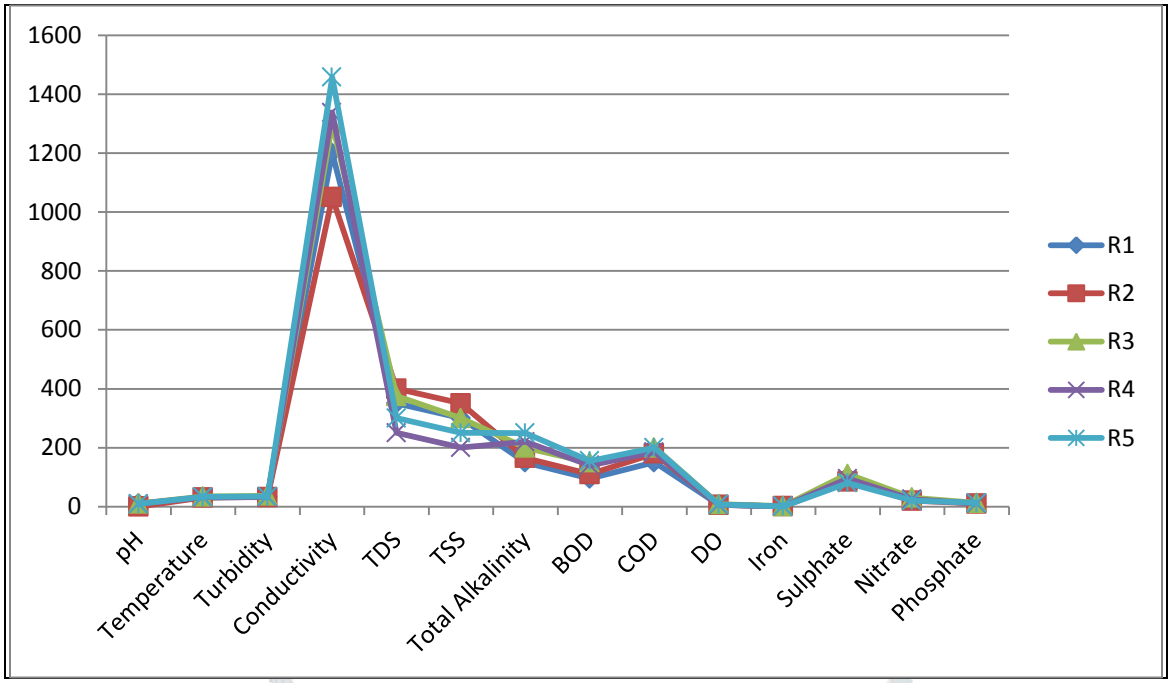
The preserved water sample was thoroughly shaken and 100 mL of water sample was measured into a beaker, then acidified by adding methyl orange with conc.H_2SO_4 and 5ml of concentrated HNO_3 was added then 2 mL of 30% hydrogen peroxide to reduce chromate (if any) and slowly boiled on a hot plate until the solution is evaporated to about 10ml. Transfer to a conical flask of 125 mL using 5 mL of conc. HNO_3. Add 10 mL conc. H_2SO_4 and a few glass beads. The heating was done continuously until the solution appeared light coloured and clear which indicated that digestion is completed. The content was not allowed to dry during digestion. 1-2ml of concentrated HNO_3 was further added to dissolve the remaining residue. The beaker walls and the watch glass were washed with distilled water and the sample was filtered to remove any insoluble material and the volume was adjusted to 100cm^3 with distilled water N. Manivasakam (2011) then transferred into 100mL glass bottle. If lead is suspected in the sample add 50 mL ammonium acetate solution. Since glass wares contribute zinc hence they are thoroughly cleansed with sodium citrate solution before determination of zinc. The resulting solution is 3N in H_2SO_4. Using aliquots of this made up solution for the determination of metals. Determination of heavy metals (copper, nickel, lead and zinc) in the wastewater samples was done by preparing samples volumetrically and using digital spectrophotometer as described in the manufacturer's instruction manual APHA (2005).

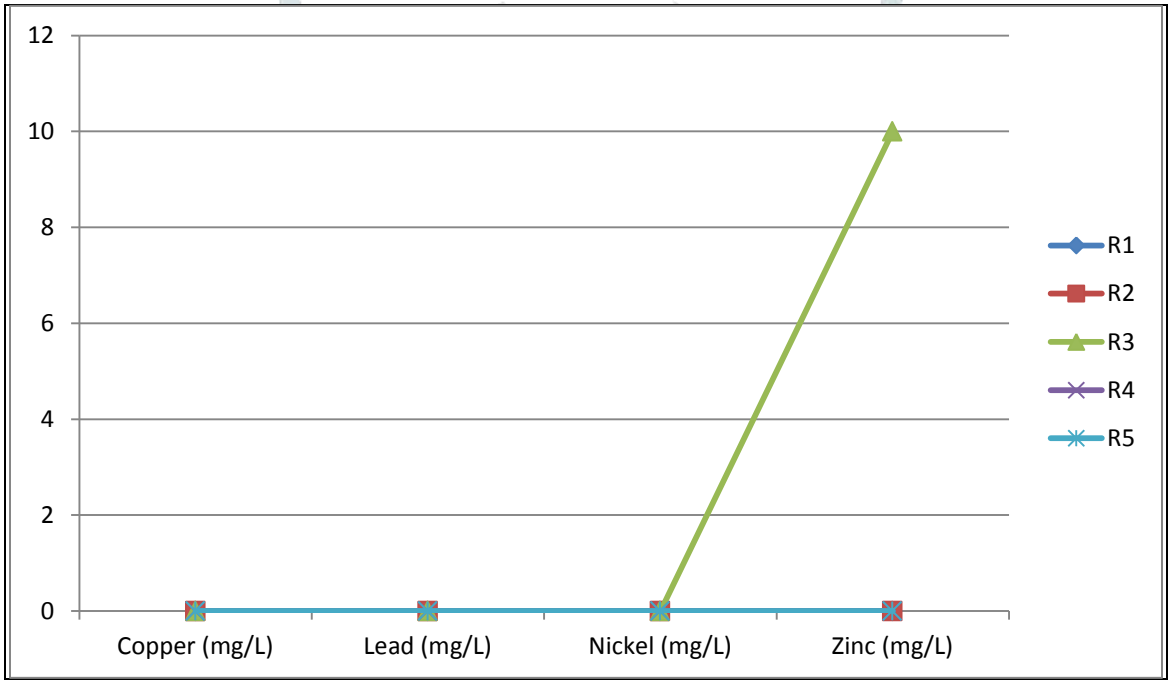
8. RESULTS AND DISCUSSION

Parameters sampling the levels of the physicochemical parameters of food waste water samples collected from renowned hotels in Raipur city are presented in Table 1. The highest value of different parameters recorded in five points is plotted in graph.

Sr. No	PARAMETERS DETERMINED	SAMPLING POINTS R1	R2	R3	R4	R5
1.	pH	9.92	7. 92	10.32	9.53	9.54
2	Temp (°C)	30.34	31.11	34.34	32.34	33.34
3	Turbidity (NTU)	33.33	32.23	37.22	33.34	34.34
4	Conductivity (µS cm-3)	1200.41	1050.17	1300.21	1337.32	1457.32
5	TDS (mg/L)	350.20	400.20	375.44	250.23	300.22
6	TSS (mg/L)	300.22	350.25	300.27	200.24	250.26
7	Total Alkalinity (mg/L)	150	165	200	220	250
8	BOD (mg/L)	95.11	110.43	150.11	140.22	155.22
9	COD (mg/l)	150.32	180.45	200.25	185.11	200.05
10	DO (mg/L)	6.40	6.25	8.45	6.35	7.83
11	Iron (mg/L)	1.0	1.0	1.5	1.0	1.0
12	Sulphate (mg/L)	100.35	85.25	110.33	95.22	80.45
13	Nitrate (mg/L)	25.33	20.15	30.35	25.10	20.25
14	Phosphate (mg/L)	10.35	10.33	12.65	10.36	12.35
15	Copper (mg/L)	BDL	BDL	BDL	BDL	BDL
16	Lead (mg/L)	BDL	BDL	BDL	BDL	BDL
17	Nickel (mg/L)	BDL	BDL	BDL	BDL	BDL
18	Zinc (mg/L)	BDL	BDL	10	BDL	BDL

BDL – Below Detectable Limit





8.1. pH of the collected water sample

The levels of pH varied between 9.92 and 7.92 for point R1 and R2; 10.32 to 9.53 for point R3, R4 and for R5 9.54 in the wastewater respectively. Generally point R3 showed the highest concentration followed by R1, while point R2 showed the least concentration. The mean pH values recorded for all the sampling point were above the municipal authorities and WHO. pH tolerance limit varying from 6.00 – 9.00 for wastewater can be discharged into sewage line with exception of point R3. The variation occured in the pH values due to change in the values of CO_2, carbonate and bicarbonate in the water. The lower values of pH may cause tuberculosis. Higher values may produce incrustation, sediment, deposition and some difficulties in chlorination for disinfections of water Asaolu (2004). In the present study the pH values in all the collected water samples ranges from 9.0 to 10 except at point R3 which are all within the limit.

8.2. Temperature (°C)

The temperature of the collected water samples varied in between 30°C to 34°C.Temperature is basically important for its effect on other properties of wastewater. Average temperature of food wastewater under investigation is 30.34ºC for R1; 31.11ºC for R2; 34.34ºC for R3; 32.34ºC for R4 and 33.34°C for R5.

8.3. Turbidity

Turbidity values were found to be in the mean of 33.33 NTU for R1; 32.23 NTU for R2; 37.22 NTU for R3; 33.34 NTU for R4 and for R5 34.34 NTU.

8.4. Conductivity

The conductivity values were found to be 1200.41µScm-3 for R1; 1050.17µScm-3 for R2; 1300.21µScm-3 for R3; 1337.32µScm-3 for R4 and 1457.32µScm-3 for R5 refer (Table 1). Conductivity of water which is a useful indicator of its salinity or total salt content is high in the food wastewater from the renowned hotels in Raipur. This result is not surprising, since wastewater from kitchen waste often contains high amounts of dissolved salts. The mean conductivity values for all the sampling point were higher than the municipal authorities and WHO guideline values of 1000µScm-3 for the discharge of wastewater through hotels into sewages Basavaraju (2011).

8.5. Total dissolved solids

The mean concentration of Total dissolved solid (TDS) in the Raipur city are presented in Table 1. The concentration of TDS is recorded as 350.20 mg/L for R1; 400.20 mg/L for R2; 375.44 mg/L for R3; 250.23 mg/L for R4 and for R5 300.22 mg/L. These values obtained for TDS in all the sampling points were below than WHO standard of 2000 mg/L for the discharged of wastewater into surface water AWWA (2006).

8.6. Total suspended solids

The total suspended solids (TSS) concentrations were found to be 300.22 mg/L R1; 350.25 mg/L for R2; 300.27 mg/l for R3; 200.24 mg/L for R4 and for R5 250.26 mg/L (Table 1).The Bureau of Indian standards has specified a maximum limit of 100 mg/L for suspended solids in waste water, dischargeable into water courses. Results of the study show that food wastewater from the major hotels in Raipur can be classified as strong wastewater and cannot be discharged into stream. DWAF (1992).

8.7. Total Alkalinity

Low alkalinity causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solders or plumbing fixtures. The permissible value of alkalinity as recommended by the Indian standards is 200 mg/L as $CaCo_3$. The amount of alkalinity concentration of the water sample collected in the study area ranged from 150 to 250 mg/L. Alkalinity and pH are the factors in determining the amenability of waste waters to biological treatment.

8.8. Biological Oxygen Demand & Chemical Oxygen Demand

(BOD) is the measure of the oxygen required by microorganisms while breaking down organic matter. While Chemical Oxygen Demand (COD) is the measure of amount of oxygen required by both potassium dichromate and concentrated sulphuric acid to breakdown both organic and Inorganic matters. BOD and COD concentrations of the wastewater were measured, as the two were of major concern. Ademoroti (1994). The waste water has an average COD concentration of 150.32 to 200.25 mg/L for point R1 to R5 refers (Table 1). BOD concentration of the wastewater obtained for point R1 to R5 ranged between 95.11 to 155.22 mg/L respectively. The concentrations of BOD and COD in all the sampling point were higher than the WHO values of 50 mg/L and 1000mg/L for the discharged of wastewater into stream. High COD and BOD concentration observed in the wastewater might be due to the use of chemicals, which are organic or inorganic that are oxygen demand in nature. The results for elemental concentration in food wastewater samples from renowned hotels in Raipur city for different sampling points are shown. From the result of these study the concentrations of all the parameters study are assumed to be in the following order R3>R4>R5>R1>R2.This variation is due to the fact that point R5 is the discharged point from Market area which is high crowded area hence consumption of food materials in hotels and restaurants is more and decrease towards point R1 less crowded area. While the high values at point R3 is due to the discharged of food wastewater from densely crowded area in city which might increase the concentration of these parameters, and finally decreased toward point R1 due to sedimentation and dilution

8.9. Dissolved oxygen

Dissolved oxygen (DO) values obtained for point R1 to R2 varied between 6.40 mg/L to 6.25 mg/L as observed in Table 1. The DO is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as the self purification capacity of the water body. The Standard for sustaining aquatic life is stipulated at 5mg/L, concentration below this value adversely affects aquatic biological life, while concentration below 2mg/l may lead to death for most fishes (Chapman, 1997). The DO level at point R1 to R5 was above these levels. An indication of organic oxygen demand content of wastewater can be obtained by measuring the amount of oxygen required for its stabilization either as BOD and COD.

8.10. Iron

Based on the assessment it is drawn that the restaurant at point R3 is significantly discharging high levels of Iron which is due to corroded pipeline which is used for the supply of water. It is a well known fact that Iron is essential to the human body. Hence it can be concluded that the low limit placed upon these metals in the standards has no health significance and the limits are based on aesthetic and taste considerations BIS (2012).

8.11. Sulphate, Nitrate & Phosphate

The concentrations of Sulphate, Nitrate and phosphate in all the sampling points varied between 80.45 mg/L to 110.35 mg/L for sulphate, 20.15 mg/L to 30.35 mg/L for nitrate and 10.33 mg/L to 12.65 mg/L for phosphate respectively refer (Table 1). High concentration of sulphate, nitrate and phosphate were observed in point R3, while low concentrations were observed for point R2. High amounts of sulphate impart bitter taste to the water Bodhaditya (2008). Sulphate as magnesium sulphate causes laxative effects to children particularly in hot weather or climates. The levels of nitrate exceeded the WHO limits of 45mg/L and Indian guideline of 0.20 mg/L. Nitrate concentration was above the limit while

sulphate was below the WHO limit of 200 mg/L for the discharged of wastewater into sewage. In addition to the naturally occurring nitrates, it is also contributed to water sources by the application of fertilizers to lands. The levels of phosphate in the entire sampling point were higher than the WHO limit of 5mg/L for the discharged of wastewater into river Chapman (1997). Polyphosphates are detrimental in that they interfere with coagulation, flocculation and lime soda treatment of water. The levels of nitrate may give rise to Methaemoglobinemia in infants also the levels of nitrate reported in this study in addition to phosphate levels can cause eutrophication and may pose a problem for other uses.

8.12. Copper, Lead, Nickel and Zinc

Copper, lead and nickel are found below detectable limit through analytically and spectrophotometric determination. Zinc was determined and obtained 10 mg/L at point R3 which is slightly above the permissible limits for sustaining of aquatic life. Although zinc poses no known adverse physiological effects upon human beings but poses adverse effects on aquatic organisms. ICMR (1975). Retention of zinc may be due to the corrosion of galvanized iron and brass in condensing, cooling and distribution system. It is reported that concentrations of zinc in soft water ranging from 0.1-1.0 mg/L are lethal to fish. As per BIS and other bodies standard limit for drinking water ranges from 5 -15 for human beings. Since zinc has a toxic effect towards protozoa and bacteria, the presence of even 0.1 mg/L zinc causes an appreciable fall in B.O.D CPCB (2000).

9. CONCLUSION

Though, the effluents were found to be rich in plant nutrients required for plant growth but due to the presence of high levels of nitrate and phosphate these waste water may not be good for irrigation in other to avoid accumulation of these elements in soils, and if the effluent are released into the environment without proper treatment, it may affect underground water and aquatic life if released into water bodies without proper treatment. Mismanagement of these waste water which are released in soils and unsanitary landfills are subjected to weathering and leaching processes by rain and other atmospheric influences resulting in the release of hazardous substances such as cyanides, minerals, heavy metals and organic acids which get to underground water systems and inland water bodies untreated. Their effects render underground and surface waters unsafe for human, recreational and agricultural use De A.K (1994). Biotic life is destroyed and natural ecosystems are poisoned. From the data collected from this research, the physicochemical parameters monitored in point R1, R2, R3, R4 and R5 showed high levels of all or some of the parameters. This must be as a result of the nature of waste water from the highly crowded area to least crowded area. Point R3 showed the highest concentration of the physicochemical parameter, and detection of zinc beyond permissible limit which poses danger to aquatic life and ecological balance while point R2 shows the lowest values. However, it is imperative that these sources should be monitored regularly and be subjected to further treatments to reduce drastically the concentrations of the few identified pollution indicators that may pose some dangers to health and society despite some pollution parameter values that are within the acceptable range of both SON (2007) and EU (1998).

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