Study on Assessment of Heavy Metal Using Surfactant and Its Environmental Effects

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Abstract

Food waste water samples were collected from selected source of Raipur. Physico-chemical parameters of the test sample were determined and metal ion concentration was determined by spectrophotometer in presence of surfactant and without surfactant. Data is compared with WHO, ICMR. The surfactant used was SDS, anionic surfactant. The cause for zinc determination was it is highly available in food stuffs or consumed as supplementary diet or gets added up externally due to knowingly or unknowingly due to one or the other reason. The inherent persistence of this heavy metal is a reason for concern, as it bio accumulates throughout the ecosystem can be found at high levels in soil, surface water, sediments, food waste water and consequently reaching the food chain (which directly or indirectly consumes the waste water) for survival of aquatic organisms.. The occurrence of heavy metal concentration can be due to inefficient water treatment before consumption through municipal authorities or contamination due to corroded pipelines and other reasons such as inclusive of food materials which are in high doses of metal concentration which affects the environment and aquatic species. The overdose of any required metal can be curse for human and biotic life. The obtained results were compared with WHO, CPCB, ICMR and were found that food waste water was remarkably polluted for aquatic organisms. With adjustment of low pH the metal ion capacity intake was normal and at high pH the absorption was high. Similarly when analysis was carried in presence of surfactant at pH 4 absorbance was found to be maximum and with increasing pH absorbance was gradually declining. Hence the main objective of this study is to analyze the extent of heavy metal(s) and to study the role of surfactant and possible harmful effects of metal ion concentration on environment and living organisms.

Key words: Food waste water, Heavy metals, Pollutants, Surfactant, Spectrophotometer

1. Introduction

Food waste water samples were collected from selected source for the determination of physico-chemical parameters and metal ion concentration using surfactants and without surfactants. Previously classical methods used such as adsorption, ion exchange, chemical precipitation and evaporation have been proved useful for the removal of metal ions from aqueous effluents [4-6]. But these methods are not capable of reducing toxic level of the metals considerably. Heavy metals are generally considered to be those whose density exceeds 5 g per cubic centimetre. A large number of elements fall into this category, but there are certain macro minerals, or those needed in large quantity, include calcium, magnesium, sodium, potassium, phosphorus, sulphur, iron, copper and zinc for the survival of life of both humans and animals. On overdoses heavy metals cause serious health effects, including reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Pb and Cd are currently being studied worldwide because of the danger they pose to animal and human food chains. Metals like Cd, Ni, Pb and Zn are known to be cumulative toxins that can affect animals including humans. High levels of these elements can be explained by their high mobility in the flora and fauna and environment. [9-10].Various researchers have demonstrated significant effect of pH and various other parameters on heavy metal removal. Juang et al. (2003) reported that cationic heavy metals (Mn^{2+}, Co^{2+}, Cu^{2+}, Zn^{2} and Cr^{3+}) removal reached over 80% with SDS as the pH increased from 2 to 12 depending upon the concentration. At the lower pH values certain heavy metals removal efficiency was due to the competition between H^{+} ions and cationic metal ions to get adsorbed on the anionic micelle surface of SDS. The objective of this paper is to determine the possible concentration of metal ion using spectrophotometric analysis method as compared to traditional method, owing to its convenience, accuracy and reliability. Depending upon the limited available resources, it's an effort to determine level of pollutant and whether drained waste water discharged is fit for aquatic and agricultural purposes.

1.1. NEED TO DETERMINE

Some heavy metals are known to be mutagens or carcinogens (He *et al.,* 2005). Different types of heavy metals were reported from terrestrial and marine wild life in Oman Sources of heavy metals include sewage water reclaimed for irrigation, land-applied wastewater sludge, municipal, industrial refuse and food waste waters obtained from kitchen drains of various restaurants, bakeries and hotels. [1,2,3]. Cu, Zn, Pb and Cd are the most environmentally concerning elements that have been often reported to cause contamination of soil, water, and food chains. There are 35 different metals that are of great concern for us because of residential or occupational exposure, out of which 23 are heavy metals, which are toxic beyond certain limits such as arsenic, antimony, bismuth, cadmium, chromium, cerium, cobalt, copper, gold, gallium, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc. These heavy metals are commonly found in the environment and diet. Exceptionally, in small amounts they are required for maintaining good health but in larger amounts they can become toxic or dangerous. As discussed earlier, heavy metal toxicity can lower energy levels and damage the functioning of the vital organs of our body. The inherent persistence of this heavy metal is a reason for concern, as it bio accumulates throughout the ecosystem can be found at high levels in soil, surface water, sediments, and consequently reaching the food chain (which directly or indirectly consumes the waste water) for their survival. In spite of significant efforts to reduce trace metals loads in wastewater, municipal waste water still conveys important amounts of trace metals into the environment. The occurrence of heavy metal concentration can be due to inefficient water treatment before consumption through municipal authorities or contamination due to corroded pipelines and other reasons such as inclusive of food materials which are in high doses of metal concentration which affects the environment and aquatic species. The objective of this research is to investigate the levels of heavy metal contamination originating from food waste sources or contaminated water (due to of any reason which directly or indirectly) harms the environment. It's an effort to study on their consequent effect on the food chain. Heavy metals contamination can be very dangerous. Many heavy metals and their compounds are highly toxic and some are also subject to bio magnification, which can lead to accumulation in the food chain. Animals at the higher food chain tend to accumulate higher concentration of toxicants in tissue from their food. Zinc (Zn) is an essential trace metal required both for human and for aquatic organism at low concentrations; at high concentrations Zn is toxic to aquatic life [1]. In the aquatic environment, the toxicity of Zn is dependent on water-quality characteristics, such as hardness, pH, alkalinity, dissolved organic carbon (DOC), and dissolved and suspended particles. In general, when alkalinity and pH increase, the concentration of free ionic Zn (Zn^{2+}) (the most bio available species) decreases as a result of complexation of (Zn^{2+}) with inorganic components (e.g., CO_3^{2-}, HCO_3^{-}, OH^{-}) to form other Zn species [7-8]. When hardness of water increases, more struggle of Ca^{2+} and Mg^{2+} with (Zn^{2+}) for binding sites at the biotic ligand will occur. This would decrease Zn bioavailability and toxicity to aquatic organisms.

1.2. ROLE OF SURFACTANT

SDS is employed in this determination. It is an anionic surfactant sodium salt of organo sulphate class. Surfactants typically promote the solubilisation of hydrophobic chemicals forming molecular aggregates called micelles, which contain hydrophobic domains where the chemicals are incorporated Kosaric Naim (2001). Owing to its easy availability SDS is mainly used in detergents for laundry with many cleaning applications. Due to it high effectiveness it is used in many tasks such as removal of oily stains and residues. In possible low concentration it is used in many household articles such as shampoos, shaving creams and toothpastes due to its surfactant properties and thickening effect. Surfactants are substances which alter the surface tension of liquids even when present in small quantities. Surfactants consists of two ends, a lyophilic and a lyophobic group; lyophilic The portion lying within the solution is lyophilic and the portion orients itself away from the solution is lyophobic. The decrease in surface tension and increase in surface viscosity is the resultant of the orientation of the surfactant which also reduces the free energy. The chemical classification of surfactant can be classified into four groups they are anionic, cationic, non ionic and amphoteric depending upon the hydrophilic and hydrophobic group. The present analysis is done by with and without the anionic surfactant to investigate its role in determination owing to its cheapness and easily availability.

2. MATERIALS AND METHODS

2.1. SAMPLE COLLECTION

Food waste water sample was collected from targeted site from Raipur area in Chhattisgarh and arranged for necessary physico-chemical parameters determination and metal ion concentration determination was carried out in presence of surfactant and without surfactant. Test sample was determined for metal ion concentration with digital spectrophotometer in presence of surfactant and without surfactant and ultimately its data was compared with WHO, ICMR and other legal bodies and graph was plotted for absorbance V/s wavelength (Plot 1.) and absorbance V/s pH (Plot 2.)

2.2. PREPARATION OF SAMPLE & METHOD

For testing of sample, to know the effectiveness of surfactant, standard aliquot samples were prepared and tested with surfactant and without surfactant by spectrophotometric method. All reagents used were of analytical grade. One gram of 3-Hydroxybenzaldehyde and one gram of 4-aminobenzoic acid was dissolved in 25 mL of distilled water and refluxed for around three hours and resultant product obtained was crystalline pale yellow coloured complex formed. After filtration the product was again re-crystallised with ethanol. Due to maximum absorbance methyl isobutyl ketone was used for the extraction of 3-hydroxy benzyl amino benzoic acid - zinc complex. [11-12]. For CMC determination surfactant (SDS) was added in multiples of 1 gm. up to 5 gm. Standard solution and stock solution was prepared. Glassware's are thoroughly cleaned with sodium citrate solution before use.[13-15]. The other tested metallic concentration had no adverse effect on the analytical signal(s) of zinc in water samples. Where analysis was not immediately possible, they were preserved to inhibit biodegradation. All the reagents used for the analysis were of analytical grade.

3. RESULTS AND DISCUSSION

TABLE 1. FOOD WASTE WATER SAMPLE: WITHOUTSURFACTANT

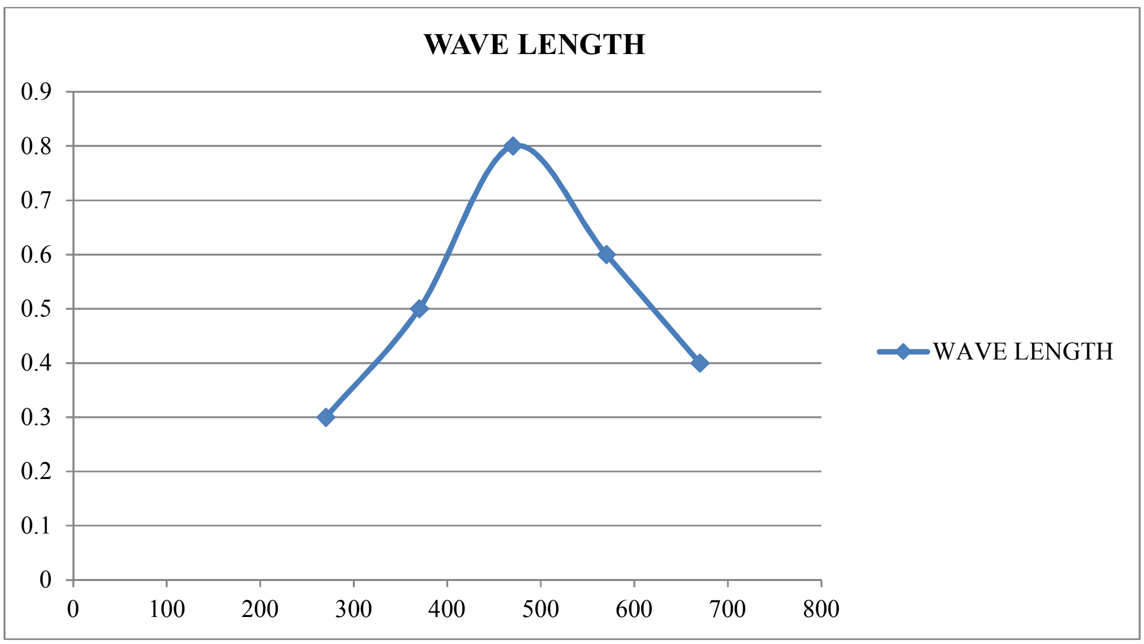
SR.NO	PARAMETERS ANALYSED	METHOD USED	INFERENCE/VALUES OBTAINED
1.	Colour	Instrumental	Yellow colour
2.	Turbidity	Instrumental	25 NTU
3.	Temperature	Thermometer	30°C
4.	Conductivity	Conductivity meter	1100 (μS cm-3)
5.	pH	Instrumental	5
6	TDS	Standard Method	375.44 (mg/L)
7.	TSS	Standard Method	300.27
8.	DO	Standard Method	10 (mg/L)
9.	BOD	Standard Method	200 (mg/L)
10.	COD	Standard Method	250 (mg/L)
11.	Zinc	UV-Spectrophotometric Analysis	15 mg/L

TABLE 2. FOOD WASTE WATER SAMPLE: WITH SURFACTANT

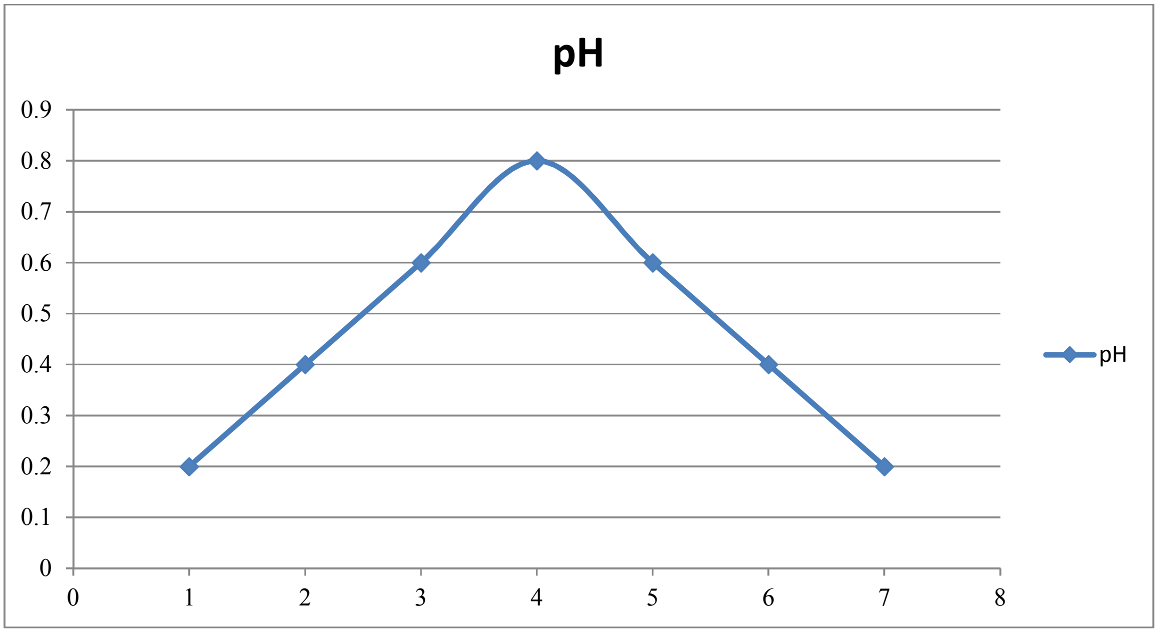
SR.NO	PARAMETERS ANALYSED	METHOD USED	INFERENCE/VALUES OBTAINED
1.	Colour	Instrumental	Light yellow colour
2.	Turbidity	Instrumental	35 NTU
3.	Temperature	Thermometer	30°C
4.	Conductivity	Conductivity meter	1200 (µS cm-3)
5.	pH	Instrumental	4.0
6.	TDS	Standard Method	300 (mg/L)
7.	TSS	Standard Method	280
8.	DO	Standard Method	8 (mg/L)
9.	BOD	Standard Method	300 (mg/L)
10.	COD	Standard Method	200 (mg/L)
8.	Zinc	UV-Spectrophotometric Analysis	10 mg/L

Graph shown below is with surfactant

Plot 1. ABSORBANCE V/s WAVELENGTH



Plot 2. ABORBANCE V/s pH



3.1. Effect of pH without surfactant: It was found that the optimum pH for metal ion concentration was at pH 5 for which maximum absorbance was recorded. The volume was increased at regular intervals of 5.0 mL for every reading. The plot between pH and absorbance was plotted graphically.

3.2. Effect of pH with surfactant: It was found that the optimum pH for metal ion concentration was at pH 4 for which maximum absorbance was recorded. Up to pH 3.5 CMC was found to be minimum. And at pH 4 CMC was maximum. The volume was increased at regular intervals of 5.0 mL for every reading. The graph between pH and absorbance was plotted.

3.3. Effect of reagent concentration: The reagent concentration was maintained at 5.0 mg/L to 10 mg/L for the maximum colour formation. The concentration effect was studied at intervals of 1:2 acid of pH 5.0 buffer. The maximum absorbance was recorded in 470 nm.

4. CONCLUSION

From the data collected from the research, it was concluded that without surfactant increase in pH beyond 5.0 the absorbance was reducing and with surfactant the absorbance was reducing beyond pH 4.0. CMC was found to be minimum up to pH 3.5 and at pH 4 CMC was maximum. With the above data it can be concluded that at targeted site Zn^{2+} was present more than the permissible limit in food waste water sample drained by restaurant which is causing harm for aquatic species and by adding surfactant the level was found to be reduced indicating the absorption of ions with surfactants. The obtained results not only indicated the need of determination of metal ion concentration but also with effect of concentration of surfactant up to certain level also remove the metal ions from waste water. The level of metal ion concentration found poses the negative effect for aquatic species by disturbing ecosystem. Therefore metals after entering the water may be taken up by fauna and flora and eventually, accumulated in marine organisms that are consumed by human being (Asaolu et al., 1997). Higher concentration of zinc leads to many adverse effects to aquatic life such as level to medium extent it kills fishes by destroying gill tissues and at severely conditions it leads to death.[16-19]. Zinc, an essential trace metal becomes toxic in the nutritional supply when it becomes excessive. Zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles. Moderately increased zinc concentrations in water are the resultant of zinc released from drainage pipes due to corrosion. It accumulates in fish and other organisms as fishes are rich in omega-3 and protein that the human body needs to stay healthy.[20-22]. Good quality of food for human consumption can only be produced in an environment free from contamination and pollution.

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REFERENCES

[1.] ASTM (American Society for Testing and Materials), 1997, Standard guide for conducting early life-stage toxicity tests with fishes, E1241-92, *in* Annual Book of ASTM Standards,Volume 11.05: Philadelphia, Pa., American Society for Testing and Materials, p. 550–577.

[2.] Amin A S, *Anal Biochem*., 2011, **418(2),** 172-179.

[3.]BIS (Bureau of Indian Standards) 10500, 2012. Specification for Drinking Water. Indian Standards Institution, New Delhi, pp. 1–5.

[4.]Chakravarty S and Mishra R K, *Fresenius' J Anal Chem*., 1993, **345(8-9)**, 613.

[5.]CPCB (Central Pollution Control Board), 2000. Water Quality Status of Yamuna River. Assessment and Development of River Basin.CPCB Report.

[6.]Ghosh.G et al, Chem. Eng. J. 119, 45 (2006).

[7.]Herrador M A, et al A G, *Analyst*, 1987, **112**, 1237-1246.

[8.]Hoshi S, et al, *Bunseki Kagaku*, 1977, **26**, 592.

[9.]ICMR (Council of Medical Research), 1975. Manual of Standards of Quality for Drinking Water Supplies, Indian. Special Report No. 44., pp. 27.

[10.]Landaburu et al. The removal of zinc from synthetic wastewaters by micellar-enhanced ultrafiltration: statistical design of experiments. Desalination. 2009 May; 240(1-3): 262-269

[11.]Niesiobedzka K, *Bull Environ Contam Toxicol.,* 2012, **88(4)**, 627-633.

[12.]Rodriguez J M B et al, *Talanta,* 1980, **27**, 923.

[13.]Sinha P P, et al, *Bull Chem Soc Japan*, 1984, **57(10)**, 2976.

[14.]Standard Methods for the Examination of Water and Wastewater. APHA-AWWAWPCF (1998).Washington D.C.

[15.]Studlar K et al, *Talanta*, 1961, **8(4),** 203.

[16.]Trivedy RK, et al. Chemical and Biological Methods for Water Pollution Studies, Environmental. India: Publication; 1986. [Google Scholar].

[17.]Trıvunac K, et al. Zinc removal from wastewater by a complexation–microfiltration process. J. Serb. Chem. Soc. 2012; 77(11): 1661-1670.

[18.]Wasey A, et al, *Curr Sci India*, 1984, **53(14),** 745.

[19.]WHO, Guidelines for drinking-water quality, 3rd edition, Recommendations. Incorporating 1st and 2nd Addenda, Vol. 1. WHO, Geneva, 2008.

[20.]World Health Organization (WHO), Nutrients in Drinking Water. Water, Sanitation and Health Protection and the Human Environment, WHO, Geneva, 2005.

[21.]Yilmaz S, et al, *Int J Electrochem Sci*., 2009, **4**,288-294.

[22.]Yoshino T, et al *Talanta*, 1974, **21(3),** 199.