Physico-chemical and microbial analysis of steel industry effluent

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Abstract- Industrial wastewater is enormously utilizing in irrigation worldwide. It is well known that physico-chemical and biological properties of wastewater influence the plant growth. In the present study, we have investigated the physico-chemical and biological properties of steel industry, Heavy Engineering Corporation Ltd. (H.E.C.) effluent. We found that most of the physico-chemical parameters were comparable to the BIS (The Bureau of Indian Standards) value for irrigation. However, conductivity, sulphate, B.O.D and C.O.D were higher than BIS value for irrigation. Moreover, microbial population was found to be higher in H.E.C. effluent as compared to tap water.

Index Terms- Heavy Engineering Corporation Ltd. (H.E.C.) Effluent, Wastewater, The Bureau of Indian Standards (BIS), Biological Oxygen Demand (B.O.D) and Chemical Oxygen Demand (C.O.D).

I. INTRODUCTION

In recent time industrial wastewater is enormously using for irrigation to recycle the water as well as utilizing it as fertilizer (Hussain, Raschid et al. 2001; Khurana and Singh 2012). This practice is more common in area where growing population economy is dependent on agriculture and simultaneously water scarcity increasing (Pescod and Arar 2013; Sato, Qadir et al. 2013). However, there are several considerable caveats for direct use of industrial wastewater in irrigation. Including advantageous nutrients industrial effluent also contains several hazardous chemicals and infectious microorganisms which could compromise and most often toxic for plant growth (Nagajyoti, Lee et al. 2010; Naidoo and Olaniran 2013; Chibuike and Obiora 2014; Balkhair 2016). Sometimes, higher amount of advantageous nutrients also inhibits the development of plant (Tchounwou, Yedjou et al. 2012; Chibuike and Obiora 2014). There are several reports which have reported the beneficial outcome of effluent in irrigation but simultaneously showed the lethal impact on plant growth (Shevah 2009; Khurana and Singh 2012; Lenin, Mariyappan et al. 2014; Ravindran, Kumari et al. 2016). Whether effluent would be beneficial or harmful for plant development is completely depends on their physico-chemical and biological characteristics (Chauhan 2014; Divyapriya, Dimi et al. 2014; Benit and Roslin 2015). If these properties are favorable for plant than it would be beneficial but if parameters are under or over the tolerance limit, then growth of plant will be compromise. Therefore, systematic analysis of specific effluent is required to know their suitable concentration for irrigation.

In this study, we investigated the physico-chemical and biological characteristics of steel industry, Heavy Engineering Corporation Ltd. (H.E.C.) effluent. H.E.C. effluent is commonly using as source of water for agriculture near their flow regions in Jharkhand, India. H.E.C. effluent not only provides water for irrigation but also contains important nutrients which are required for plant growth. Therefore, farmer use H.E.C. effluent to get nutrients for plant growth which economically overcomes the cost problem associated with fertilizers. Effluent could be harmful if their physico-chemical and biological parameters are not optimum for specific plants. Thus, it is worth to systematically analyze the physico-chemical and biological parameters of H.E.C. effluent to better understand their properties.

II. MATERIALS AND METHODS

H.E.C. effluent was collected at regular interval of six months from the H.E.C. plant Ranchi, Jharkhand, India. APHA procedure was used to analyzed the physico-chemical properties of H.E.C. effluent (APHA 1995). In this study we analyzed various physico-chemical parameters such as temperature (^oC), TDS (ppm), turbidity (NTU), pH, conductivity (µʊ), alkalinity (meq./l), hardness (mg/l), chloride (mg/l), phosphate (mg/l), sulphate (mg/l), nitrate (mg/l), BOD (mg/l) and COD (mg/l). All the experiments were performed in quadruplicate and data were expressed as average value. Further microbial examination of H.E.C. effluent was performed. For this, different dilutions (0%, 20%, 40%, 60%, 80% and 100%) of H.E.C. effluent were prepared using distilled water. We spread one milliliter of different dilutions of H.E.C. effluent (0% - 100%) as well as tap water (control) on nutrient agar medium (NAM) plate and incubated at 37^oC for a day. We visually scored the colonies that were grown on plate after incubation. Simultaneously, we also analyzed their phenotypic characteristic appearance such as colour.

III. RESULTS

Systematic analysis of different physico-chemical properties of H.E.C. effluent

H.E.C. effluent was collected four-times after interval of six months and their different properties of physico-chemical analysis were performed. H.E.C effluent colour was not uniform and varies with time of collection. Colour of the effluent was found to be light green, grey, transparent and brown in first,

second third and fourth collection time, respectively. Likewise, H.E.C. effluent odour was also varies with time of collection and it was musty in first, greasy in second and fourth and no smell in third collection time.

The average value of physical and chemical properties of H.E.C. effluent greatly varies as compared to standard recommended value of BIS for irrigation (table 1). H.E.C. effluent temperature (^{o}C), TDS (ppm) and turbidity (NTU) were found to be 24.75 (BIS, 40), 299.25 (BIS, 2100) and 27.55 (BIS, 510) respectively. H.E.C. effluent pH, conductivity (µʊ) and alkalinity (meq./l) were found to be 7.07 (BIS, 6.0-9.0), 405.75 (BIS, 400), and 200 (BIS, 200-600), respectively. H.E.C. effluent hardness (mg/l) and Chloride (mg/l) were 236.75 (BIS, 300-600) and 45.54 (BIS, 600), respectively. The content of phosphate (mg/l), sulphate (mg/l) and nitrate (mg/l) in H.E.C. effluent values were 1.03 (BIS, 5), 167.5 (BIS, 150), and 25.5 (BIS, 50), respectively. Moreover, BOD (mg/l) and COD (mg/l) of H.E.C. effluent was found to be 52.25 (BIS, 30) and 271.75 (BIS, 250), respectively. These analyzed results indicate that most of the characteristic parameters of H.E.C effluent were comparable to the BIS recommended value for irrigation.

Table 1. Quantitative analysis of physico-chemical properties of H.E.C effluent collected on four different time points.

Parameters	**Average Value**	**BIS Value**
Temperature (^{o}C)	24.75	40.0
Turbidity (NTU)	27.55	510
TDS (ppm)	299.25	2100
pH	7.07	6.0-9.0
Conductivity (µʊ)	405.75	400
Alkainity (meq./l)	200	200-600
Hardness (mg/l)	236.75	300-600
Chloride (mg/l)	45.54	600
Phosphate (mg/l)	1.03	5
Sulphate (mg/l)	167.5	150
Nitrate (mg/l)	25.5	50
BOD (mg/l)	52.25	30
COD (mg/l)	271.75	250

Microbial analysis of H.E.C. effluent

Wastewater could contain microorganisms and their population completely depends on origin of source. Pathogenic microorganisms infect the plant and thus affect their development and growth. Thus, we examined the microbial population of H.E.C. effluent and compared their number of colonies with tap water. We found that number of microbial colonies were higher in 100% concentration H.E.C. effluent as compared to tap water (table 2). Total number of colonies forming unit per milliliter (CFU/ml) was approximately 1300 in 100% concentration H.E.C. effluent however it was approximately 400 CFU/ml in tap water. CFU was gradually decreased with lowering the concentration of H.E.C. effluent which is simply an outcome of dilution. Moreover, colony colour was varies at different concentrations of H.E.C. effluent. Colonies were appeared as white, blue and yellow in colour suggesting the mixed population of different groups in H.E.C. effluent (table 2). These results reveal that H.E.C. effluent contain different microorganisms than tap water however their number is less at lower concentrations (20% - 40%) of H.E.C. effluent.

Table 2. Microbial analysis of H.E.C effluent at different dilutions.

H.E.C. effluent concentration	CFU/ml	Colony colour
Tap water	400 - 500	White
20%	100 - 150	White, yellow, blue
40%	300 - 350	White, yellow
60%	700 - 800	White, yellow, blue
80%	1000 - 1100	White, yellow
100%	1300 - 1400	White, yellow

IV. DISCUSSION

Previously, we have reported the effect of H.E.C. effluent on morphological development of *Vicia faba* (Naaz, Swaroopa et al. 2017). We found that development of different morphologies of *Vicia faba* was maximum at lower H.E.C. effluent concentrations (Naaz, Swaroopa et al. 2017). In the present study, we have systematically analyzed the physico-chemical properties of H.E.C. effluent. Moreover, we also analyzed the microbial load in H.E.C. effluent. We found that most of the common physico-chemical parameters such as temperature, pH, turbidity, salinity, hardness, chloride, alkalinity, T.D.S, phosphorous and nitrogen were within the BIS recommended range. However, conductivity, sulphate, B.O.D and C.O.D value were slightly higher than the BIS recommended range. The increase in conductance of effluent could correlate with increase in sulphate concentration in H.E.C effluent. If sulphate combines with an alkaline metal the salt that forms may be able to conduct electricity, because of the cations and anions. Increase in B.O.D and C.O.D reveal that there is increase of microbial load in H.E.C. effluent (Aslam, Baig et al. 2004; Popa, Timofti et al. 2012; Benit and Roslin 2015). Indeed, we found that H.E.C. effluent contains several microorganisms of different phenotypic characters.

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