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Study of Electroplating Industry Effluent in Relation to Growth and Metabolism of Barley (*Hordeum vulgre* L.) Plants

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Abstract: The present investigation deals with the effect of electroplating industrial effluent on the seed germination , morphological characters such as shoot and root length , yield in terms of total fresh weight and dry weight, photosynthetic pigments (chlorophyll and carotenoid content), sugar and protein concentrations, catalase, peroxidase and the activity of amylase in a barley plants. It was observed that germination , plant growth, photosynthetic pigments (Chlorophyll a, chlorophyll b, total chlorophyll and carotenoid content), proteins and amylase activity of barley plants were found to be adversely affected with the increasing concentrations of electroplating industry effluent. A significant stimulation in sugar concentration was observed at lower concentration of electroplating effluent. Activities of two important iron enzymes such as catalase and peroxidase were significantly increased in barley plants at increasing concentrations of effluent.

Keywords: Electroplating industry effluent, Barley, Growth, Pigments, Sugar, Protein , Catalase, Peroxidase and Amylase

Introduction: In today's ecosphere, pollution is one of the biggest challenges that are faced by the living beings. There is a continuous deterioration in current ecosystem and quality of life due to various pollutants from different sources. One of the major source of pollution which affects our mother nature is increase in number of industries . Although , industries are important for growth but the ignorance of it's negative aspects is very harmful for the environment. Discharge of industrial effluents into water bodies and disposal of hazardous poisonous wastes into land pits without consideration of safety standards , pollution level both in land and water has increased significantly . Pollution growth at such a rapid rate will not only affect land an water bodies nearby industries but also the places located at far away will have to bear harmful consequences . This would have an impact on marine life and degradation in soil quality . Anything consumed by human being with such a degraded flora and fauna would cause fatal diseases. In order to avoid such a situation, industrial waste must be channelized properly to improve soil productivity. Present paper covers brief overview on various treatments and it's influence in maintaining the sustainability of upcoming future.

Materials and Methods: Seeds of barley (*hordeum vulgare* L.) were used as test material . Four concentrations of treated effluents (25, 50, 75 and 100%) and control (glass distilled water) were taken for the study in triplicate. Petridishes were properly washed with detergents and then tap water washing followed by hydrochloric acid (HCl) washing and finally washed with deionised and glass distilled water. Twenty five seeds

were placed on filter paper in each petridish and then soaked with controlled solution and solution of various concentrations of effluents in the temperature range of 20 to 30°c. The germinating seeds and seedlings were washed with distilled water every alternate day for the prevention of contaminants and fresh solutions were applied for the maintenance of effluent concentration. Solutions of respective effluents were superimposed on the basal solutions. Germination studies were conducted under lab conditions. For germination studies, the number of seeds germinated was noted and accordingly the germination percentage was calculated. Root length and shoot length were recorded after two weeks of growth. Plants were harvested for fresh weight and dry weight yield.

The basal nutrient solution was prepared by the method of Hewitt (1966).Chlorophyll, Protein and Sugar concentration were measured by the method of Petering et al. (1940), Lowry et al. (1951) and Dubias et al. (1956) respectively. Activities of enzymes catalase and peroxidase were assayed by the modified method of Bisht (1972) and modified method of Luck (1963) respectively. Amylase activity was assayed by the method of Katsuni and Frekuhara (1969).

Results and Discussion:

The effect of different concentrations of electroplating industry effluent was observed on growth and yield of barley plants. The results indicate that increasing concentration of effluent decreased the germination percentage of barley. All the studied plants exhibited maximum inhibition in germination at 100% effluent. Germination was 96.00 in control and it decreased to 84.00, 80.00, 68.00 and 64.00 % respectively. It was12.5, 16.67, 29.17 and 33.33 % decrease at 25,50,75 and 100% concentration respectively than the control. The results are shown in (Table-1). The results clearly revealed that the effect of different concentrations (25,50,75 and 100%) of electroplating industry effluent had inhibitory effect on the shoot and root length of the barley plants. The result showed that the shoot length and root length was significantly decreased at increasing concentrations of effluent. Decreased shoot length was at the rate of 11.87, 18.65, 23.73 and 42.38% and root length was at the rate of 5.00, 10.00, 16.67 and 26.67% at 25, 50, 75 and 100% concentration respectively than the control. Total fresh weight showed significantly decrease while total dry weight showed non-significantly decrease at increasing concentration of effluent (Table-1). Basu and Rao (2013) investigated the effect of electroplating industry effluent on the germination and growth of cowpea (*Vigna unguiculata* L) seedlings at different concentrations of effluent and they found that higher concentrations of the effluent produced harmful effect on germination , root and shoot growth (both length and biomass). Wastewater from electroplating processes contains high concentrations of heavy metals (Namerow and Dasgupta, 1991). Inhibition of growth might be due to fact that heavy metals present in the effluent (Jerome and Fergusan 1972).

Metabolic activities

Chlorophyll: Supply of different concentrations of effluent showed significant reduction in the concentration of chlorophyll a, chlorophyll b , total chlorophyll in plants. Carotenoid content in plants was also affected adversely at increasing concentrations of effluent (Table-2). Reduction in chlorophyll may be due to the induced inhibition of electron transport system in PS-II (Izawa, S. 1997). According to Hendry and Grime (1993), decreased chlorophyll and carotenoid may also be due to the oxidative stress which is a marker of the tissue aging as result of the stress factors of the environment.

Sugar: Sugar concentration was significantly increased at 25% dose of effluent while significant decrease was observed at 50 to 100% concentration of effluent. The maximum increase in sugars was observed at 25%

concentration of effluent which was 44.91% as compared to control (Table -3). Enhancement of sugar at lower concentration of effluent might be due to lack of proper translocation of sugar from leaf to root. According to Murata et al. (1969), increased amount of sugar might be either due to inhibition in starch synthesis from hexose or stimulation of starch hydrolysis.

Protein: Protein concentration was found to be significantly reduced at increasing concentration of effluent. It was 18.75, 25.00, 41.65 and 62.50% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-3). According to Ericson and Alfinito (1984) abiotic stress may inhibit a synthesis of some proteins and promote others .

Catalase : The catalase activity was found to be significantly increased at increasing concentration of effluent . It was 2.996, 24.78, 126.90 and 149.18 increase at 25, 50, 75 and 100% concentration respectively than control. The maximum increase was observed at higher concentration of effluent as compared to control (Table-4). Catalase, the antioxidant enzyme can be used as bioindicator of metabolic functions and are known to be induced by many stress factors, including heavy metals (Van Assche et al., 1988, Subhadra et al., 1991).

Peroxidase : The peroxidase activity was found to be significantly increased. It was 12.11, 32.39, 79.93 and 190.66% increase at 25, 50, 75 and 100% concentration respectively than the control (Table-4). According to Lin and Kao, (2000) plants posses a number of antioxidant molecules and enzymes that protect against oxidative damage. In the present study the activity of peroxidase was found to be increased at increasing concentrations of effluent. According to Ali et al.(2003) elevated Peroxidase activity suggests its role in constant detoxification of H_2O_2 in metal toxicity.

S.No.	Effluent Concentration(%)	Germination (%)	Shoot Length(cm)	Root Length(cm)	Total Fresh Weight (g)	Total Dry Weight(g)
1.	Control	96.000^{a} ±2.309	19.667^{a} ±0.882	10.00^{a} ±0.577	0.208^{a} ±0.026	0.013 ±0.002
2.	25	84.00^{ab} ±4.000 (-12.5%)	17.333^{b} ±0.882 (-11.87%)	9.500^{b} ±0.289 (-5.00%)	0.197^{b} ±0.019 (-5.29%)	0.013^{NS} ±0.002 (0.00%)
3.	50	80.000^{ac} ±0.000 (-16.67%)	16.000^{ac} ±0.764 (-18.65%)	9.000^{c} ±0.289 (-10.00%)	0.118^{ab} ±0.021 (-43.27%)	0.007^{NS} ±0.004 (-46.15%)
4.	75	68.000^{abc} ±0.000 (-29.17%)	15.000^{ad} ±0.577 (-23.73%)	8.333^{a} ±0.333 (-16.67%)	0.115^{ab} ±0.006 (-44.71%)	0.008^{NS} ±0.002 (-38.46%)
5.	100	64.000^{abc} ±0.000 (-33.33%)	11.333^{abcd} ±0.667 (-42.38%)	7.333^{abc} ±0.167 (-26.67%)	0.0950^{ab} ±0.013 (-54.33%)	0.005^{NS} ±0.003 (-61.54%)

Amylase: Activity of amylase in barley plants was significantly decreased at increasing concentration of effluent. It was 28.57, 33.32, 57.14 and 76.18% decrease at 25, 50, 75 and 100% concentration respectively than

the control (Table-4). Nath et al . (2007) also reported decreased amylase activity with increasing concentration of treated combined effluent in wheat, barley, garden pea and black gram.

Table 1. Effect of different concentrations of Electroplating industry effluent on germination percentage, growth and biomass yield of barley (*Hordeum vulgare* L.) plants.

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. NS=non significant. The values given in the bracket shows the percent increase or decrease as compared to control.

Table 2. Effect of different concentrations of Electroplating industry effluent on pigment contents of barley (*Hordeum vulgare* L.)plants.

S.No.	Effluent concentration (%)	Chlorophyll a (mg/g FW)	Chlorophyll b (mg/g FW)	Total chlorophyll (mg/g FW)	Carotenoid (mg/g FW)
1.	Control	0.490^{a} ±0.008	0.226^{a} ±0.006	0.716^{a} ±0.013	0.558^{a} ±0.006
2.	25	0.476^{b} ±0.012 (-2.86%)	0.220^{b} ±0.014 (-2.66%)	0.695^{b} ±0.010 (-2.93%)	0.466^{ab} ±0.012 (-16.49%)
3.	50	0.401^{abc} ±0.008 (-18.16%)	0.140^{ab} ±0.012 (-38.05%)	0.541^{abc} ±0.019 (-24.44%)	0.365^{abc} ±0.009 (-34.59%)
4.	75	0.378^{abd} ±0.005 (-22.86%)	0.131^{ab} ±0.006 (-42.04%)	0.509^{abd} ±0.011 (-28.91%)	0.354^{abd} ±0.004 (-36.56%)
5.	100	0.314^{abcd} ±0.007 (-35.92%)	0.110^{ab} ±0.005 (-51.33%)	0.424^{abcd} ±0.012 (-40.78%)	0.313^{abcd} ±0.005 (-43.91%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows the percent increase or decrease as compared to control.

Table 3. Effect of different concentrations of Electroplating industry effluent on the concentrations of sugar and protein of barley (*Hordeum vulgare* L.)plants.

S.No.	Effluent concentration (%)	Sugar Concentration (mg/g FW)	Protein Concentration(%FW)
1.	Control	2.300^{ab} ±0.076	1.904^{a} ±0.000

2.	25	3.333[a] ±0.076 (+44.91%)	1.547[ab] ±0.069 (-18.75%)
3.	50	2.267[ac] ±0.088 (-1.44%)	1.428[ac] ±0.137 (-25.00%)
4.	75	1.900[abcd] ±0.058 (-17.39%)	1.111[abCd] ±0.079 (-41.65%)
5.	100	1.600[abcd] ±0.115 (-30.44%)	0.714[abcd] ±0.000 (-62.50%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows the percent increase or decrease as compared to control.

Table 4. Effect of different concentrations of Electroplating industry effluent on the activity of different enzymes in barley (*Hordeum vulgare* L.)plants.

S.No.	Effluent concentration(%)	Catalase activity (μ moles H_2O_2 decomposed/min/mg Protein)	Peroxidase activity(ΔOD/mg protein)	Amylase activity(starch hydrolyzed in mg/gm FW)
1.	Control	53.397[ab] ±0.877	1.445[ab] ±0.009	2.800[a] ±0.231
2.	25	54.997[ab] ±0.578 (+2.996%)	1.620[ab] ±0.118 (+12.11%)	2.000[ab] ±0.231 (-28.57%)
3.	50	66.627[ab] ±6.826 (+24.78%)	1.913[ab] ±0.157 (+32.39%)	1.867[ac] ±0.133 (-33.32%)
4.	75	121.153[b] ±7.703 (+126.90%)	2.600[ab] ±0.225 (+79.93%)	1.200[abc] ±0.231 (-57.14%)
5.	100	133.053[a] ±4.044 (+149.18%)	4.200[a] ±0.081 (+190.66%)	0.667[abc] ±0.133 (-76.18%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows the percent increase or decrease as compared to control.

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