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Selvaraj K *

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Research Article

Bioadsorption – To Clean Match Industry Effluent Toxicity

Selvaraj K *, Makesh Kumar B

Department of Botany, G. Venkatasamy Naidu College (Autonomous), Kovilpatti, (Affiliated to Manonmaniam Sundaranar University, Tirunelveli), Tamil Nadu, India.

***Corresponding Author:** Selvaraj K, Department of Botany, G. Venkatasamy Naidu College (Autonomous), Kovilpatti, (Affiliated to Manonmaniam Sundaranar University, Tirunelveli), Tamil Nadu, India.

Received date: March 13, 2023; **Accepted date:** March 21, 2023; **Published date:** March 30, 2023

Citation: Selvaraj K, Makesh Kumar (2023), Bioadsorption – To Clean Match Industry Effluent Toxicity, *J, Biotechnology and Bioprocessing*, 4(1); **DOI:**10.31579/2766-2314/086

Abstract

This study investigates the possibility of applying an adsorption process using seaweed dry powder natural seaweeds the adsorbents were used to treat real match industry effluent. Bioadsorption is an effective low-cost tool for cleaning polluted environment. In the present study the seedlings of Vigna mungo (L) Hepper were treated with various concentrations of match industry effluent and their impact on the growth, biochemical and enzyme characters were studied. After fourteen days treatment with different concentration of match industry effluent (20%, 40%, 60%, 80% and 100%) the growth parameter such as,shoot and root lengths, leaf area, fresh weight and dry weight were decreased than the control. Biochemical parameters such as chlorophyll, carotenoids, soluble sugar, protein content and nitrate reductase activity also decreased with the increase in the concentration of cobalt chloride. But the content of free amino acid, proline, phenol and leaf nitrate content were increased with the increase in the concentration of cobalt chloride. The activities of enzyme such as catalase, peroxidase and polyphenol oxidase were found to be increased with the increase in the concentration of match industry effluent. Application of seaweed (Sargassum wightii) in different concentrations (2gm/L, 4gm/L and 6gm/L) on 60% efluent treated plants has shown the stress relieving effect caused by the toxins of match industry effluent. It is good low cost bioadsorbant for match industry effluent pollution.

Key Words: bioactive compounds; phytochemical compounds; essential oils; polyphenols

Introduction

Water is the source of life on Earth. However, various human activities, such as industrial, domestic usage, or agricultural, cause its pollution. For instance, there are still significant quantities of dyes in wastewater coming from textile, tannery industry, sugarcane industry, and dyeing industries. The release of these effluents causes an abnormal coloration of the surface waters. Match industry effluents are particularly high in inorganic content and colour, which gives the water bodies an unappealing hue. Several of the hazardous metals used in the match industry are discovered to be cancer-causing, and the presence of colour inhibits light penetration and water bodies' ability to photosynthesize (Roshan, et al., 2000). Treatment techniques such ozonation, chemical coagulation, adsorption, and electrochemical technology can be used to treat these waste effluents. Use of plants to degrade, assimilate, metabolise, or detoxify toxins is cost-effective and ecologically good for the restoration and management of our natural water resources because these chemical treatment procedures need expensive chemicals and also generate toxic sludge. When these industrial effluents from surrounding companies are released through drainage without being properly treated, they reach agricultural areas and seriously damage the town's ecology (Ramasubramanian, et al., 2006).

Seaweeds are one of the most important resources in the world. They are large group of marine benthic algae. Seaweeds are the best material for biosorption because their macroscopic structures offer a convenient basis for the production of biosorbent particles for sorption process. Macro algae are the group of marine plants classified on the basis of pigmentation into green, brown and red algae and also major primary producers in the marine environment, play an important role in energy transfer. Bioadsorbants are prepared from naturally abundant biomass. They offer several advantages for bioadsorption because of their large surface area. The use of seaweed as manure is very common in coastal areas throughout the world. Seaweed extracts have been marketed for several years as fertilizer additives and beneficial results from their use. Seaweed extracts contain macronutrients, trace elements, and plant growth regulators such as auxin, cytokinin and gibberellins (Williams et al., 1981). Seaweeds used as a soil amendment increases soil N, K and Mg, which may be beneficial for crop production.

This study aimed to found out the impact of various concentration of Match industry effluent on Vigna mungo (L) Hepper and the effect of varying amount of dried natural biomass of Sargassum wight with 6mM Match industry effluent on the growth, pigment, biochemical and enzymatic characteristics of Vigna mungo (L.) Hepper.

Materials and Methods

The Match industry effluent was collected from the Match industry in Kovilpatti. The sample for analysis was preserved as per the standard recommended procedure. The seaweed Sargassum wightii collected from Harberpoint coast near Tuticorin were shade dried and finally powdered by milling. Various concentrations of seaweed powder were prepared with 60% Match industry effluent.

Both control and experimental seeds were allowed to grow in uniform mixed red, black and sandy soil in 1:1:1 ratio. After ten days, seedling of Vigna mungo (L.) Hepper were treated with various concentration of Match industry effluent (20%, 40%, 60%, 80% and 100% v/v). After ten days of effluent treatment, various morphometric, biochemical and enzymatic characteristics were analyzed. In another set 60% of effluent (the concentration at which toxicity was found to be optimum level based on LST analysis). was subjected to various concentration of seaweed (Sargassum wightii) powder (2g/ L, 4g/L and 6g/L w/v), for 24 hours. Then filtered and the filtrate was used to treat plants. After ten days of treatment, various morphometric, biochemical and enzymatic characteristics were analyzed.

Twenty days old plants of Vigna mungo (L.) Hepper. were used for measuring the morphometric characters such as root length, shoot length, leaf area, fresh weight and dry weight were measured. The biochemical and enzymatic characters were analyzed by the following methods: chlorophyll and carotenoids (Wellburn and Lichtenthaler, 1984) anthocyanin (Swain and Hills, 1959) Total soluble sugar (Jayaraman, 1981) Protein content (Lowry, et al., 1951) amino acid content, leaf nitrate (Cataldo, et al., 1978) in vivo nitrate reductase activity (Jaworski, et al., 1971) peroxidase and catalase activity (Kar and Mishra, 1976).

Results

Effect of five different concentrations (2mM, 4mM, 6mM, 8mM, and 10mM) of match industry effluent on the growth, biochemical and enzyme activities are represented in Table 1 to 4.

Growth Parameters	Control	20%	40%	60%	80%	100%
Root Length (cm)	13.9 ±0.148 (100)	11.66 ±0.789 (84)*	9.73 ±0.167 (70)*	8.72 ±0.647 (63)*	6.30 ±0.114 (45)*	4.19 ±0.158 (30)*
Shoot Length (cm)	18.69 ±0.152 (100)	14.74 ±0.164 (79)*	12.55 ±0.336 (67)*	10.23 ±0.390 (55)*	8.03 ±0.705 (43)*	6.03 ±0.416 (32)*
Leaf Area (cm2)	4.6 ±0.370 (100)	3.761 ±0.378 (81)*	3.33 ±0.354 (72)*	2.73 ±0.365 (59)*	1.94 ±0.249 (42)*	1.19 ±0.476 (26)*
Fresh Weight (gm)	0.690 ±0.021 (100)	0.575 ±0.146 (79)*	0.475 ±0.049 (69)*	0.351 ±0.067 (51)*	0.268 ±0.041 (39)*	0.183 ±0.015 (27)*
Dry Weight (gm)	0.139 ±0.070 (100)	0.086 ±0.022 (61)*	0.065 ±0.014 (47)*	0.043 ±0.123 (31)*	0.033 ±0.015 (24)*	0.025 ±0.419 (18)*

Table 1: Effect of various concentration of Match industry effluent on the Growth parameters of Vigna mungo (L.) Hepper.

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error; *Significantly different from the control at P<0.05

Pigments	Control	20%	40%	60%	80%	100%
Total Chlorophyll (mg/gLFW)	2.710 ±0.007 (100)	2.184 ±0.032 (81)*	1.709 ±0.023 (63)*	1.465 ±0.048 (54)*	1.298 ±0.035 (48)*	0.986 ±0.017 (36)*
Carotenoids (mg/gLFW)	1.513 ±0.008 (100)	1.079 ±0.016 (71)*	0.936 ±0.018 (62)*	0.823 ±0.011 (54)*	0.727 ±0.011 (48)*	0.606 ±0.013 (40)*
Anthocyanin (A. units/g LFW)	1.024 ±0.011 (100)	1.438 ±0.01 (140)*	1.673 ±0.009 (163)*	1.824 ±0.017 (178)*	2.085 ±0.01 (203)*	2.210 ±0.007 (216)*

Values in parenthesis indicate percent activity; value represents mean of 3 samples with their standard error; *Significantly different from the control at P<0.05.

Table 2 Effect of various concentration of Match industry effluent on the Pigments of Vigna mungo (L.) Hepper.

Parameters	Control	20%	40%	60%	80%	100%
Total Soluble Sugar (mg/g LFW)	69.06 ±0.424 (100)	55.07 ±0.112 (78) *	47.41 ±0.291 (69) *	39.78 ±0.208 (58) *	23.62 ±0.275 (34) *	15.71 ±0.103 (23) *
Total Soluble Protein (mg/g LFW)	9.16 ±0.213 (100)	7.42 ±0.239 (81) *	5.94 ±0.073 (65) *	4.23 ±0.087 (46) *	3.30 ±0.171 (36) *	2.03 ±0.034 (22) *
Amino acid (µg/g LFW)	23.07 ±0.265 (100)	33.51 ±0.318 (145) *	42.54 ±0.664 (184) *	55.99 ±0.167 (243) *	70.05 ±0.268 (304) *	74.03 ±0.256 (322) *
Proline (µg/g LFW)	2.417 ±0.033 (100)	2.751 ±0.021 (114) *	2.919 ±0.010 (121) *	3.154 ±0.041 (130) *	3.423 ±0.007 142) *	3.671 ±0.010 (152) *
Leaf Nitrate (µg/g LFW)	19.55 ±0.306 (100)	27.17 ±0.450 (139) *	35.05 ±0.167 179) *	47.49 ±0.579 (243) *	51.11 ±0.100 261) *	65.54 ±0.256 (335) *
Total Phenol (µg/g LFW)	0.159 ±0.0014 (100)	0.180 ±0.0017 (113) *	0.198 ±0.0003 125) *	0.215 ±0.0015 (135) *	0.253 ±0.0026 (159) *	0.282 ±0.002 (177) *

Values in parenthesis indicate percent activity; value represents mean of 3 samples with their standard error; *Significantly different from the control at P<0.05

Table 3: Effect of various concentration of Match industry effluent on the Biochemical characteristics of Vigna mungo (L.) Hepper.

Parameters	Control	20%	40%	60%	80%	100%
Nitrate Reductase activity (µ mole of NO_2 formed /hour LFW)	15.83 ±0.064 (100)	12.31 ±0.118 (78)*	10.93 ±0.073 (69)*	9.79 ±0.040 (62)*	8.12 ±0.026 (51)*	6.91 ±0.098 (44)*
Catalase activity (µmoleof H_2O_2 formed/min. LFW)	1.73 ±0.032 (100)	2.34 ±0.037 (135)*	3.79 ±0.051 (219)*	4.91 ±0.023 (284)*	5.84 ±0.056 (338)*	7.14 ±0.116 (413)*
Peroxidase activity (µmole of H_2O_2formed/ min.LFW)	0.017 ±0.0005 (100)	0.024 ±0.0003 (141)*	0.029 ±0.0005 (171)*	0.032 ±0.0003 (188)*	0.036 ±0.0003 (212)*	0.040 ±0.0003 (235)*
Polyphenol Oxidaseactivity (µ mole ofH_2O_2 formed/ min. LFW)	0.986 ±0.008 (100)	1.147 ±0.009 (116)*	1.433 ±0.084 (145)*	1.683 ±0.009 (171)*	1.850 ±0.006 (188)*	2.045 ±0.077 (207)*

Table 4: Effect of various concentration of Match industry effluent on the Enzymes activities of Vigna mungo (L.) Hepper.

The results shows that growth parameters such as root length, shoot length, leaf area, fresh weight and dry weight decreased with the increase in the concentration of match industry effluent. Similarly, Chlorophylls, Carotenoid, Total Soluble Sugar, Protein and NR activity were also in a declining trend. In contrary the pigment Anthocyanin, total free amino acid, proline, phenol and the antioxidant enzyme such as peroxidase, catalase and polyphenol oxidase activity increase with the increase in the match industry effluent concentration.

Growth Parameters	Control	Control (60%)	60% Match industry effluent with		
			2 gm /L SWP	4 gm /L SWP	6 gm /L SWP
Root Length (cm)	13.9 ±0.148 (100)	8.72 ±0.647 (63)*	10.38 ±0.114 (75)*	11.91 ±0.529 (86) *	12.99 ±0.180 (93)*
Shoot Length (cm)	18.69 ±0.15 (100)	10.23 ±0.390 (55)*	14.77 ±0.236 (79)*	16.03 ±0.332 (86)*	17.42 ±0.271 (93)*
Leaf Area (cm^2)	4.6 ±0.370 (100)	2.73 ±0.365 (59)*	3.56 ±0.170 (77)*	3.88 ±0.116 (84) *	4.35 ± 0.138 (95)*
Fresh Weight (gm)	0.690 ±0.021 (100)	0.351 ±0.067 (51)*	0.579 ±0.446 (84)*	0.616 ±0.284 (89)*	0.679 ±0.183 (98)*
Dry Weight (gm)	0.139 ±0.070 (100)	0.043 ±0.123 (31)*	0.105 ±0.067 (76)*	0.616 ±0.284 (89) *	0.133 ± 0.056 (96)*

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error; *Significantly different from the control at P<0.05; SWP- Sea Weed Powder.

Table- 5 Effect of Sargassum wightii treated match industry effluent on the Growth parameters of Vigna mungo (L.) Hepper.

Remediation studies shows that the growth parameters such as root length, shoot length, leaf area, fresh and dry weight of the plant were increased by increasing the amount of dried seaweed powdered with 60% match industry effluent treated Vigna mungo plant (Table 5). The chlorophyll and carotenoid contents had been significantly increased after the application of seaweed treated effluent in Vigna mungo seedlings. The anthocyanin content was decreased by the application of seaweed treated match industry effluent seedlings

Pigments	Control	Control (60%)	60% Match industry effluent with		
			2 gm /L SWP	4 gm /L SWP	6 gm /L SWP
Total Chlorophyll (mg/glow)	2.710 ±0.007 (100)	1.465 ±0.048 (54)*	1.983 ±0.008 (73)*	2.245 ±0.008 (83)*	2.505 ±0.010 (93)*
Carotenoids (mg/gLFW)	1.513 ±0.008 (100)	0.823 ±0.011 (54)*	0.993 ±0.007 (66)*	1.183 ±0.009 (78)*	1.364 ±0.0093 (90)*
Anthocyanin (A. units/g LFW)	1.024 ±0.011 (100)	1.824 ±0.017 (178)*	1.525 ±0.0066 (149)*	1.402 ±0.0055 (137)*	1.225 ±0.012 (120)*

Values in parenthesis indicate percent activity; value represents mean of 3 samples with their standard error; *Significantly different from the control at P<0.05; SWP- Sea Weed Powder.

Table- 6 Effect of Sargassum wightii treated match industry effluent on the Pigments of Vigna mungo (L.) Hepper.

Total soluble sugar, soluble protein and invivo nitrate reductase contents were significantly increased in the seedlings after the application of seaweed treated match industrty effluent. In contrary, total free amino acid, proline content and phenol content were reduced after the application of treated industry effluent (Table 7). The activities of enzymes such as catalase, peroxidase

Parameters	Control	Control (60%)	60% Match industry effluent with		
			2gm\L SWP	4gm/L SWP	6gm/L SWP
Total Soluble Sugar (mg/g LFW)	69.06 ±0.424 (100)	39.78 ±0.208 (58) *	49.87 ± 0.511 (72)*	55.40 ± 0.313 (80)*	66.71 ± 0.383 (97)*
Total Soluble Protein(mg/g LFW)	9.16 ±0.213 (100)	4.23 ±0.087 (46) *	6.46 ±0.215 (71)*	7.28 ± 0.157 (79)*	7.94 ± 0.057 (87)*
Amino acid (µg/g LFW)	23.07 ±0.265 (100)	55.99 ±0.167 (243) *	40.89 ± 0.261 (177)*	32.86 ± 0.102 (143)*	26.43 ± 0.240 (115)*
Proline (µg/g LFW)	2.417 ±0.033 (100)	3.154 ±0.041 (130) *	3.038 ±0.013 (126)*	2.926 ±0.014 (121)*	2.779 ± 0.026 (115)*
Leaf Nitrate (µg/g LFW)	19.55 ±0.306 (100)	47.49 ±0.579 (243) *	32.57 ± 0.055 (167)*	24.87 ± 0.148 (127)*	21.12 ± 0.201 (108)*
Total Phenol (µg/g LFW)	0.159 ±0.0014 (100)	0.215 ±0.0015 (135) *	0.243 ± 0.0034 (153)*	0.202 ±0.0034 (127)*	0.185 ± 0.0024 (116)*

Values in parenthesis indicate percent activity; value represents mean of 3 samples with their standard error; *Significantly different from the control at P<0.05; SWP- Sea Weed Powder.

Table- 7 Effect of Sargassum wightii treated match industry effluent on the Biochemical characteristics of Vigna mungo (L.) Hepper.

and polyphenol oxidase activity in the Vigna mungo seedlings had been reduced after the application of seaweed treatment, whereas the nitrate reductase activity was increased by the application of seaweed powdered. (Table 8).

Parameters	Control	Control (60%)	60% Match industry effluent with		
			2 gm /L SWP	4 gm /L SWP	6 gm /L SWP
Nitrate Reductase activity (µ mole of NO_2 formed /hourLFW)	15.83 ±0.064 (100)	9.79 ±0.040 (62)*	11.90 ±0.086 (75) *	13.27 ±0.0145 (84) *	14.21 ±0.155 (90) *
Catalase activity (µ moleof H_2O_2 formed/min.LFW)	1.73 ±0.032 (100)	4.91 ±0.023 (284)*	3.33 ±0.043 (170) *	2.72 ±0.076 (157) *	2.06 ±0.015 (114) *
Peroxidase activity (µmole of H_2O_2 formed/ min.LFW)	0.017 ±0.0005 (100)	0.032 ±0.0003 (188)*	0.027 ±0.0015 (159) *	0.020 ±0.0016 (118) *	0.018 ±0.0003 (105) *
Polyphenol Oxidase activity (µ mole of H_2O_2formed/ min. LFW)	0.986 ±0.008 (100)	1.683 ±0.009 (171)*	1.1540 ± 0.0043 (122) *	1.089 ±0.0040 (115) *	1.015 ±0.0035 (107) *

Values in parenthesis indicate percent activity; value represents mean of 3 samples with their standard error; *Significantly different from the control at P<0.05; SWP- Sea Weed Powder.

Table- 8 Effect of Sargassum wightii treated match industry effluent on the Enzymes activities of Vigna mungo (L.) Hepper.

Discussion

In the present study, the increases in the concentrations of match industry effluent caused considerable reduction on the root and shoot length of Vigna mungo (L.) Hepper. Similar results were also observed due to excess supply of match industry effluent in black gram (Jayakumar and Vijayarengan, 2006). The toxins in the match industry at high levels may inhibit the root and shoot growth directly by inhibition of cell division or cell elongation or a combination of both resulting in the limited exploration of the soil volume for uptake and translocation of nutrients and water and induced mineral deficiency was reported (Hemantaranjan et al., 2000).The pronounced inhibition of shoot and root growth are the main case for the decrease in fresh and dry weight of seedlings, uptake of toxins from the industry effluent occurs primarily through the root (Arduini et al.,1996).

The decrease in leaf area at higher concentrations of match industry effluent could be attributed to either, a reduction in the number of cells in the leaves of Phaseolus vulgaris, or to a reduction in cell size was reported. The decreased in leaf area under effluent stress was due to the reduced cell size and decreased intercellular spaces (Purohit et al., 2003). The decrease in fresh weight and dry matter content can be attributed to decrease in potassium, calcium and magnesium content of plants when they are supplied with high levels of metal ions. Hosono et al. (1979) showed that the heavy metal toxicity depends upon one or more nutrients concentration within the plants.

The photosynthetic process is related with the inhibition of biomass accumulation, which in turn relies upon the pigment level. The photosynthetic pigments such as chlorophyll 'a‟, chlorophyll „b‟, total chlorophyll and carotenoid contents of black gram decreased with increasing concentration of match industry effluent. In the present investigation, the excess effluent treatment brought about a marked depression in photosynthetic pigments in plants. It might be due to excess supply of cobalt resulting in interference with the synthesis of chlorophyll. The formation of chlorophyll pigments depends on the adequate supply of iron (Jain et al., 2001) It was suggested that protoporphyrin, the precursor for chlorophyll synthesis decreased after match industry effluent treatment.

The anthocyanin content was significantly increased with increasing concentration of industrial effluent. Anthocyanins are cationic polyphenol and exhibits antioxidant activity by inhibiting the lipogenase. The anthocyanin accumulated in the upper epidermal cells of the leaves, exposed to heavy metal could act as scavengers, before it reaches the sensitive targets such as chloroplast and other organelles (Mazza et al., 1999). Hence the increase in anthocyanin after metal treatment can be ascribed with its protective function. The synthesis of anthocyanin has been proposed as a regulator for the increased synthesis of phenol.

The reduction in sugar contents may be attributed to reduction in chlorophyll contents of the leaf and also a decline in protein. This change might have already affected the photosynthetic activity of the plant and hence the reduction in contents (Swaminathan et al., 1998). Kastori et al., (1992) reported in Helianthus annus that content of soluble proteins decreased with high concentration of heavy metals. Protein content under heavy metal influence may be affected due to the enhanced protein hydrolysis resulting in decreased concentration of soluble proteins.

Accumulation of free aminoacid is considered as an adaptive mechanism employed by the plant cell to overcome post stress metabolism. In the present investigation the free amino acid content was increased with the increase in match industry effluent treatment. It may be due to destruction of protein or to increase in the biosynthesis of amino acids from the nitrate source which were not utilized in the protein synthesis (Sharma et al., 1997).

Accumulation of proline has been frequently used as biochemical marker for water stress in plants (Schat et al., 1997). In stress condition the inhibition of growth of cells, leaves and the whole plant were accompanied by an accumulation of nitrate in plant tissue particularly in leaves (Sinha and Nicholas, 1981). The leaf nitrate content was found to be more in nickel treated plants paralleling with the reduction in nitrate reductase activity.

Peroxidase is an enzyme which utilizes hydrogen peroxide as a substrate and it also oxidizes a wide range of hydrogen donors such as phenolic substances cytochrome – c oxidase. The increased peroxidase activity caused a major impact on the chlorophyll degradation. Peroxidase could also act as IAA oxidase (Balasinha,1982). The peroxidase activity was reported to be increased with the increase in the concentration of the industrial effluent, it causes a major impact on the chlorophyll degradation. Catalase is antioxidant and scavenging enzyme; it was found to be increased with the increasing concentration of cobalt chloride. Catalase is special type of peroxidase enzyme which catalase the degradation of H_2O_2, which is natural metabolite and also toxic to plants (Balasinha, 1982).

Polyphenol oxidase and peroxidase are the two major enzyme which are responsible for oxidation of phenolic compound such as polyphenols and ideal for radical scavenging activity. Polyphenoloxidase involved in the reduction of oxidative damage triggered by reactive oxygen species through stress experienced plant. These antioxidant enzymes and metabolites are reported to increase under various environmental stresses and with the application of fungicide and salt treatment in medicinal plants (Yu and Rengel, 1999).

The dry seaweed biomass reduces the toxic effect of cobalt chloride and thereby promotes the growth of Vigna mungo The algae Sargassum wightii is a very good biosorbent of heavy metals. This finding clearly indicates that addition of dry seaweed biomass reduces the toxic effect of industrial effluent and thereby promotes the growth of Vigna mungo. The increased in the growth may be due to the presence of phenyl acetic acid (PAA) in the seaweed extract (Taylor and Wilkinson, 1977). The growth promoting activity of the plants may be attributed to the presence of hormone in the seaweed extracts. It has been suggested that hormones like cytokinin present in the seaweed extracts may be responsible for their growth promoting activity (Stephen et al., 1985). Marine algae contain a high amount of organic substances, such as carbohydrates, protein, lipids and pigments. Menon and Srivastava, (1984) reported an increase in the number and size of the chloroplast and better grana development after seaweed application. The cell wall of brown algae generally contains components namely cellulose, alginic acid and salts of potassium, sodium, magnesium and calcium and sulfated polysaccharides (Wang and Chen, 2009).

An increase in sugar, protein and decrease in free amino acid, proline and phenol accumulation, after the application of seaweed powder indicated the promotive nature of the seaweed. This positive response was observed even in low concentration of seaweed. It was also reported that, after seaweed application there was increase in the protein level and decrease in proline level (Ramasubramanian et al., 2004). The seaweed application has caused a reduction in proline and phenol accumulation than the stressed plants, indicating the plants response in overcoming stress effect by the seaweed application even at low concentration. This finding coincides with the findings of Jayakumar and Ramasubramanian (2009) who reported that the application of Sargassum wightii powder on the chromium treated plants showed improvement in plant growth.

Nandagobal and Subramanian (2004) who observed that the seaweed stimulates the nitrate reductase activity and protein synthesis. Catalase, peroxidase and polyphenol oxidase activity are the enzymes responsible for scavenging the plant materials from the stressed impact. On application of seaweed, these enzyme activities decreased considerably than the control plants. Arunkumar et al., (2002) reported that, seaweed is having potential to reduce the activity of scavenging enzymes.

The peroxidase activity was found to be decreased by seaweed treatment. This showed the remediation property of the seaweed application. The dried algal biomass used in the present study is available in large quantities which could be used to remove metals. Thus, seaweed could be used as an effective, safe and economical alternative was also reported (Jayakumar and

Ramasubramanian, 2009). The findings of present study shows that the algae Sargassum wightii and dry powder can efficiently remove the match industry effluent toxicity.

Conclusion

In the present study, it has been experimentally proved that the use of seaweeds is the best biosorbent. We have reviewed the sources and toxicology of heavy metals as well as the reason why they need to be removed from our environment. Conventional methods of removal are expensive and hence the uses of low-cost abundant environment friendly biosorbents have been tested. The present investigation on the use of dried algal biomass available in large quantities for removal of toxins from industrial effluent has tremendous potential as an economic effective safe alternative. Innovative, economically feasible and novel biomass regeneration and conversion of the recovered metal into usable form are the best options to attract more usage of biosorbents. The result of the present investigation clearly shows that the use of Sargassum wightii can efficiently remediate the toxicity of match industry effluent. Hence, we strongly suggest that Sargassum wightii can be used as a biosorbent of toxicity of the match industry effluent polluted environment for sustainable agriculture.

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DOI: 10.31579/2766-2314/86