The Faculty is Nationally Activated by NAQAAE no. 137 in 19/1/2015

The Impact of Bioremediation on Heavy Metals Toxicity Uptake from Industrial Wastewater Effluent

Thesis Submitted by

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In

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(2020)

Contents

Subject	Page
Introduction	1
Review of Literature	4
Materials and Methods	29
1. Samples collection:	29
2. Determination of heavy metal concentrations in the wastewater samples:	29
3. Bacteria isolation (Marzan et al., 2017):	29
4. Tolerance of bacterial isolates to six heavy metals:	30
5. The activities of bacterial isolates:	30
5.1. On bacterial growth curve	30
5.2. On indole acetic acid (IAA) production (color change)	31
5.3. Antibiosis activities of the ten bacterial isolates	31
6. Biological and molecular identification of the selected bacterial isolates:	31
7. Selected bacterial isolates (T1) Bacillus spp., (T3) B.cereus and (T4) B.altitudinis effects:	32
8. *Azolla filiculoides* as (fresh & dry) effects:	33
9. Bacterial isolates (*Bacillus* spp, *B. cereus* and *B. altitudinis*) combined with *Azolla filiculoides* (fresh & dry) effects:	34
10. Statistical analysis:	35
Results & Discussion	36
1. Determination of heavy metals concentrations in the (IWW) Industrial Wastewater samples:	36
2. Cultivation test of the isolated microorganisms grown on NA medium and inoculated with dilutions of IWW (1.00, 0.5, 0.25ml):	37
3. Bacterial isolates resistance to heavy metals assay:	37
3.1. Inhibition zone dimension (diameter cm)	37
4. Effect of industrial wastewater (IWW) toxicity on the growth curve and IAA production of the selected isolated bacteria (T1, T2, T3, T4, T5, T6, T7, T8, T10 & T18):	41
4.1. On bacterial growth curve	41
4.2. On Indole Acetic Acid (IAA) reaction	43
4.3. Antibiosis activities of bacterial isolates (T1, T2, T3, T4, T5, T6, T7, T8, T10 & T18) with *F. solani*, *S. rolfsii* and *E. coli*	44
5. Characterization of selected bacterial isolates (T1, T3 &T4):	47
5.1. Molecular identification of three bacterial isolates based on the nucleotide sequences of 16S rRNA gene.	49
6. Bioremediation effects on the removal% of six heavy metals from industrial wastewater (IWW):	51
6.1. Role of selected bacterial isolates (*Bacillus* spp., *B. cereus* and *B. altitudinis*) on the biosorption of six heavy metals (Zn^{+2}, Fe^{+2}, Co^{+2}, Cd^{+2}, Cu^{+2}& Pb^{+2}) from industrial wastewater (IWW).	51
6.2. The effects of *Azolla filiculoides* treatments as fresh.	55
6.3. The effects of *Azolla filiculoides* treatments as dry.	58
6.4. Combined effects of bacterial isolates (*Bacillus* Spp., *B. cereus* and *B. altitudinis*) & *Azolla filiculoides* as fresh.	62

6.5. Combined effects with bacterial isolates (*Bacillus* Spp., *B. cereus* and *B. altitudinis*) & *Azolla filiculoides* as dry.	65
Summary	69
Conclusion and Recommendation	74
References	76
Appendages	

List of tables

Table No.	Titles	Page No.
1	**Heavy metal contents in EIWW of (Abu kerqas sugar factory, El-Minia, Egypt).**	36
2	**Heavy metals (Zn^{+2}, Fe^{+2}, Co^{+2}) susceptibility of the 30 bacterial isolates assay.**	39
3	**Heavy metals (Cd^{+2}, Cu^{+2}, Pb^{+2}) susceptibility of the 30 bacterial isolates assay.**	40
4	**Degree of color changes of 10 bacterial isolates to producing IAA.**	44
5	**Antibiosis activities of 10 bacterial isolates against *F. solani*, *S. rolfsii* & *E.coli*.**	45
6	**Morphological, biochemical, characterization and utilization of carbohydrate tests of bacterial isolates (T1, T3 & T4).**	48
7	**Sequences producing significant alignments of the three bacterial strains compared to those similar strains in Gen Bank with E-value (0.0).**	50
8	**Initial and residual values of heavy metals (ppm) in IWW as affected by SIWW inoculated with the selected bacteria.**	53
9	**Removal efficiency % of heavy metals from IWW as affected by SIWW inoculated with the selected bacteria.**	54
10	**Initial and residual values of heavy metals in IWW as affected by Af with treatments.**	57
11	**Removal efficiency % of heavy metals from IWW as affected by Af with treatments.**	57
12	**Initial and residual values of heavy metals in IWW as affected by Ad with treatments.**	60
13	**Removal efficiency % of heavy metals from IWW as affected by Ad with treatments.**	61
14	**Initial and residual values of heavy metals in IWW as affected by combined treatments of selected bacterial isolates with Af.**	64
15	**Removal efficiency % of heavy metals from IWW as affected by the combined treatments of selected bacterial isolates with Af.**	64
16	**Initial and residual values of heavy metals in IWW as affected by combined treatments of selected bacterial isolates with Ad.**	67
17	**Removal efficiency % of heavy metals from IWW as affected by the combined treatments of selected bacterial isolates with Ad.**	67

List of figures

Figure No.	Titles	Page No.
1	**The Main drain of Abu Kerqas Sugar Factory (27°55'28.8"N 30°49'00.4"E).**	29
2	**Cultivation of different concentrations of wastewater sample on the forming of Bacillus spp. colonies.**	37
3	**Observation of resistance and sensitive action of bacterial isolates.**	41
4	**Optical density (λ = 620 nm) of 10 bacterial isolates as affected by the growth periods.**	42
5	**Optical density (λ = 620 nm) of three selected bacterial isolates as affected by growth periods.**	43
6	**Photos show the color changes degree of 10 bacterial isolates for IAA.**	44
7	**Photos show the antibiosis activities between Bacillus sp. against others organisms compared to the growth alone to everyone.**	46
8	**Phylogenetic trees of the three bacterial strains compared to those similar strains in GenBank.**	51
9	**Average of the mean values (A) of the heavy metals removal % of IWW as affected by SIWW inoculated with the 3 selected isolates.**	54
10	**Average of the mean values (B) of the different six heavy metals removal % from IWW.**	54
11	**The interaction (AB) effect between the treatments & six heavy metals removal % of IWW.**	55
12	**Average of the mean values (A) of the heavy metals removal % of wastewater effluent as affected by treatments combined with *Azolla filiculoides* as fresh.**	58
13	**Average of the mean values (B) of the different six heavy metals removal % from IWW.**	58
14	**The interaction (AB) effect between the treatments combined with *Azolla filiculoides* as fresh & six heavy metals removal % of IWW.**	58
15	**Average of the mean values (A) of the heavy metals removal % of wastewater effluent as affected by treatments with *Azolla filiculoides* as dry.**	61
16	**Average of the mean values (B) of the different six heavy metals removal % from IWW combined with *Azolla filiculoides* as dry.**	61
17	**The interaction (AB) effect between the treatments combined with *Azolla filiculoides* as dry & six heavy metals removal % of IWW.**	62
18	**Average of the mean values (A) of the heavy metals removal % from IWW as affected by combined SIWW with selected bacterial isolates and Af treatments.**	65
19	**Average of the mean values (B) of the different six heavy metals removal % from IWW.**	65
20	**The interaction (AB) effect between the combined treatments & six heavy metals removal % of IWW.**	65

21	**Average of the mean values (A) of the heavy metals removal % from IWW as affected by the combined SIWW with selected bacterial isolates and Ad treatments.**	68
22	**Average of the mean values (B) of the different six heavy metals removal % from IWW.**	68
23	**The interaction (AB) effect between the combined SIWW with selected bacterial isolates and Ad treatments & six heavy metals removal % from IWW.**	68

ABSTRACT

The most serious problems of the environment are heavy metals toxicity throughout the industrial activities even in traces that harms for ecological system. Initially total of 30 isolates were screened on nutrient agar medium containing heavy metals: zinc, iron, cobalt, cadmium, copper and lead at four different concentrations (25, 50, 75 and100µg/mL in their salt form). Three isolates of *Bacillus* sp. were isolated from effluent industrial wastewater of Abu Kerqas Sugar Factory (27°55'28.8"N 30°49'00.4"E), identified by using 16S rRNA gene, and documented in GenBank as *Bacillus* spp. SMMAA-1 (LC472522), *Bacillus cereus* SMMAA-3 (LC472523), *Bacillus altitudinis* SMMAA-4 (LC472524).

The bacterial isolates which were selected based on their growth curve; IAA reaction and antibiosis effect were identified based on their morphological, biochemical characterization and utilization of carbohydrates as carbon sources. These isolates were evaluated for their abilities to bio-remediate the toxic heavy metals.

The experimental results showed that bacteria present resistance of six heavy metals. *B.cereus* is significantly effective for removal efficiency percentage of six heavy metals (Zn^{+2}, Fe^{+2}, Co^{+2}, Cd^{+2}, Cu^{+2}& Pb^{+2}) (94.77%) from Industrial Wastewater than *Bacillus* spp. (83.19%) and *B.altitudinis* (83.21%). The higher removal efficiencies by bacterial isolates were found with Co^{+2}, Cd^{+2}& Cu^{+2} and the lowest removal biosorption were recorded with Fe^{+2} ion.

Our results demonstrated that the importance for the dilution process for bioremediation to fast bio absorption or detoxifying of the heavy metals from the wastewater polluted to obtain the good results. The highest removal efficiency % was recorded with Zn^{+2} (72.26%) even though, the removal efficiency % of Cu^{+2} and Pb^{+2} were below (37.09% & 48.47%). The effective treatment was founded when SIWW was diluted by tap water 50% and treated with *Azolla filiculoides* as fresh.

In case of *azolla filiculoides* as dry we noted that the highest removal efficiency % was observed by the diluted treatment (SIWW50% + tap water 50% +Ad) with Zn^{+2} ion (82.97%) while the lowest removal % was recorded by the 100% SIWW + Ad with Cu^{+2} ion (49%).

When used the combined of *Azolla filiculoides* fronds as fresh (Af) with the isolated bacteria (*Bacillus* spp., *B. cereus* & *B. altitudinis*) the results were obtained that the maximum removal % of heavy metals were observed as followed (Zn^{+2} > Co^{+2} > Cd^{+2} > Pb^{+2} > Cu^{+2} > Fe^{+2}) and the values of its metals were (99.68% > 99.61

% > 99.30 % > 99.11 % > 97.67% > 95.38 %) respectively. The best combined treatments for removal % of heavy metals was founded with the combined treatment (Af + Bacillus spp.) with Co^{+2} ion (99.91%). The lowest removal % was observed with the treatments (Af+ *Bacillus* spp.) and (Af + *B. cereus*) with Fe^{+2} (95.19%).

Also, when used the combined of *Azolla filiculoides* fronds as dry (Ad) with the isolated bacteria (*Bacillus* spp., *B. cereus* & *B. altitudinis*) the results were obtained that the removal % of heavy metals arranged from the high to low (from 99.88% for Co^{+2} to 94.40% for Fe^{+2}) as followed $Co^{+2} > Cd^{+2} > Zn^{+2} > Pb^{+2} > Cu^{+2} > Fe^{+2}$. The all combined treatments of *Bacillus* spp., *B. cereus* and *B. altitudinis* + Ad with Co^{+2} showed highly removal % (99.92 %, 99.86% and 99.86%) respectively. The lowest removal % by the above mentioned combined treatments mean were recorded with Fe^{+2} (94.40%).

Key words: Bioremediation, Phytoremediation, Heavy metals, toxicity, Industrial Wastewater, Effluent, *Bacillus* spp., *Bacillus cereus, Bacillus altitudinis, Azolla filiculoides.*