Phytoremediation of Mercury Contaminated Soil Using *Scripus Mucronatus* Exposed by Bacterias

A. Yavar, S. Sarmani, A. Hamzah, and K. S. Khoo

Abstract: Realizing the mechanisms of plant growth promotion and capability of phytoremediation of a plant is vital when deciding what type of bacteria to utilize with a plant in a given contaminated situation. Effect of two types of bacterias namely *Brevundimonas diminuta* and *Alcaligenes faecalis* were inspected on *Scripus mucronatus* grown in 1 ppm Hg contaminated soil. The *Scripus mucronatus* cut to five identical pieces and elemental concentrations of them were determined using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) technique after 1th and 42th days. The results were denoted which these two bacterias were recognized as plant-grown promoting rhizobacteria and they can enhance the heavy metal uptake from soil contaminated.

Keywords: Mercury contamination, *Brevundimonas diminuta* and *Alcaligenes faecalisin* bacterias, ICP-OES, *Scripus mucronatus*, Phytoremediation.

I. Introduction

HEAVY metals are among the most general contaminants in the environment. Mercury (Hg) has been used for minimum the past 2500 years caused by its unique chemical and physical properties. Mercury is extended into the environment in substantial amounts by anthropogenic activities, and it has been verified to become a potent neurotoxin. The global mercury production since the creation of the industrial revolution has been assessed at 0.64 million metric tons. It is assessed that the annual anthropogenic input of mercury into the environment is as high as 6×106 kg/yr. Combining both anthropogenic input and natural source, about 741×106 kg mercury has been released into the atmosphere, 118×106 kg released in water, and 806×106 kg released into soils [1]. The distribution of large quantities of mercury into the environment has concluded in its widespread occurrence in the whole food chain [2]. The U.S. Environmental Protection Agency has reported Ag, As, Ba, Be, Cd, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, and Zn as potentially toxic elements [3].

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Since the traditional techniques for remove contaminations of soil are expensive, treatment using phytoremediation, which is cost-effective and environmentally friendly has been used expansively. Phytoremediation is a process that uses plants to reduce and remove contaminants from the environment. Soil contamination is an essential environmental problem. Remediation technologies are required to resolve the problem of soil contaminated with Hg, which are compounds used by a variety of industries [4]. Adam and Duncan (2002) reported that grasses are the best to be utilized in remediation of contaminated soil because of their fibrous root systems with extensive surface area for microbial colonization [5]. In present study, *Scirpus mucronatus* was used to phytoremediate Hg from soil. *Scirpus mucronatus* is a perennial tropical aquatic plant, with the universal names of *giant bulrush*, *greater club-rush* and *rumput menderong* (Malaysia), *mensiang*, and *walingi* (Indonesia). It is a plant with fibrous roots in white or brown color, solid and triangular stems, simple leaves, not lobed or divided, more than 2 m long/wide, hairy on both sides, leaf sheath present, triangular in cross section, with bisexual flowers grouped together. The *Scirpus mucronatus* grows in moist and wet terrestrial habitat, and in shallow water [6-10].

To improve the phytoremediation method, it is essential for plants to grow as large as possible in the presence of various environmental contaminants. One way to attain this aim is to employ plant growth-promoting bacteria to facilitate the growth of the plants utilized for phytoremediation [6-9]. The objective of present study was evaluation of two bacterial inoculums namely *Brevundimonas diminuta* and *Alcaligenes faecalisin* in phytoremediation of *Scirpus mucronatus* planted in mercury contaminated soil.

II. Experimental Method

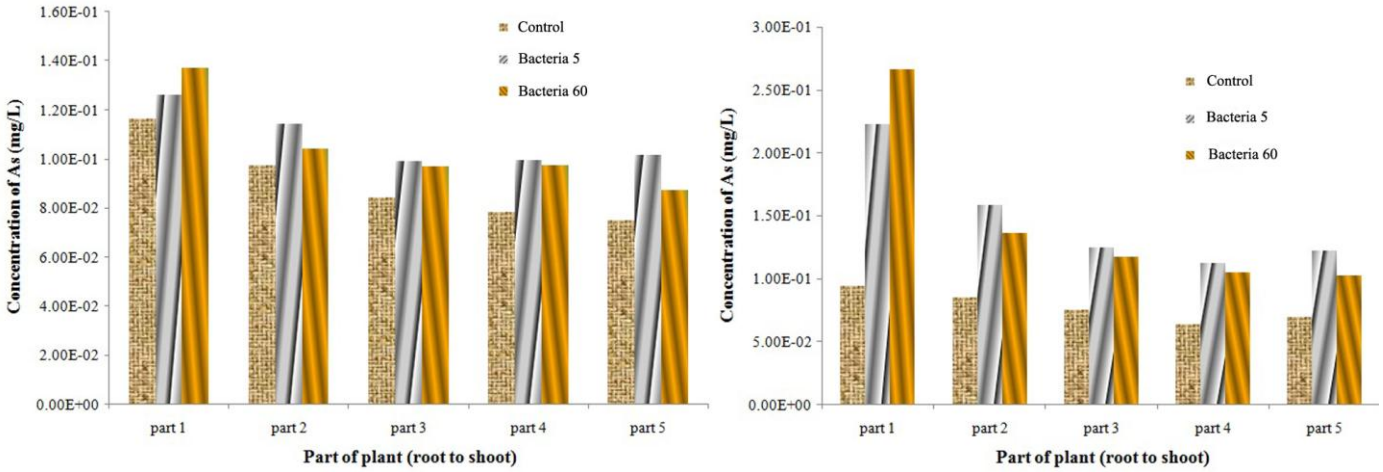
Scirpus mucronatus was propagated from seeds in a green house in Universiti Kebangsaan Malaysia using soil garden in polyethylene crates (40 cm – 58 cm – 30 cm dimensions). After 5 weeks, Hg solution and bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) were added into crates. Samples were prepared from the *Scirpus mucronatus* grown on 1th, and 42th days, the samples were rinsed by Milli-Q water to remove dust-borne contamination, afterward each plant was cut to 5 identical pieces from root to shoot. The samples were dried in oven at 90 °C for 2 days. Consequently, 200 mg

samples were weighed in heat-resistant tubes; 5 mL 69% HNO_3 and 3 mL H_2O_2 were added, then samples were heat in microwave for 55 min with 1400 W energy. Finally, samples were diluted to 50 mL with Milli-Q water. Digested samples were analyzed for multi-element analysis by ICP-OES method. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) is a powerful tool for calculation of metals elements concentration in a variety of different sample matrices [8, 11-12].

III. Results And Discussion

Three types of samples were investigated in present study. Two types of samples were enriched by Bacteria 5 and Bacteria 60; as well another one was grown without bacteria (control sample). Fig. 1 to Fig. 11 were exhibited the concentration of toxicity elements of As, Be, Cd, Cu, Mn, Mo, Ni, Pb, Sb, Se, and Zn in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of enrichment. Control samples were used to assess effects of bacteria 5 and bacteria 60 on plant growth promotion and capacity of phytoremediation of *Scirpus mucronatus*. The concentrations of elements on 42th day were higher than 1th day. As the results proven, the concentration of elements in samples used by bacteria 5 and bacteria 60 were higher than control sample. As well, the concentration of elements in control samples after 42 days were lower than 1th day. By comparison of results it is obvious, these two bacterias can be useful for heavy metal up-taking from soil contaminated and increase phytoremediation in *Scirpus mucronatus*.

Scirpus mucronatus is known as a phytoremediation plant which it also grows in Malaysia [12]. As a result, utilizing the bacteria 5 and bacteria 60 for growing up of the *Scirpus mucronatus* can be use as powerful approach to decrease toxicity elements in environment in Malaysia.



a. Concentration of As on 1th day

b. Concentration of As on 42th day

Fig. 1 Concentration of As in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).

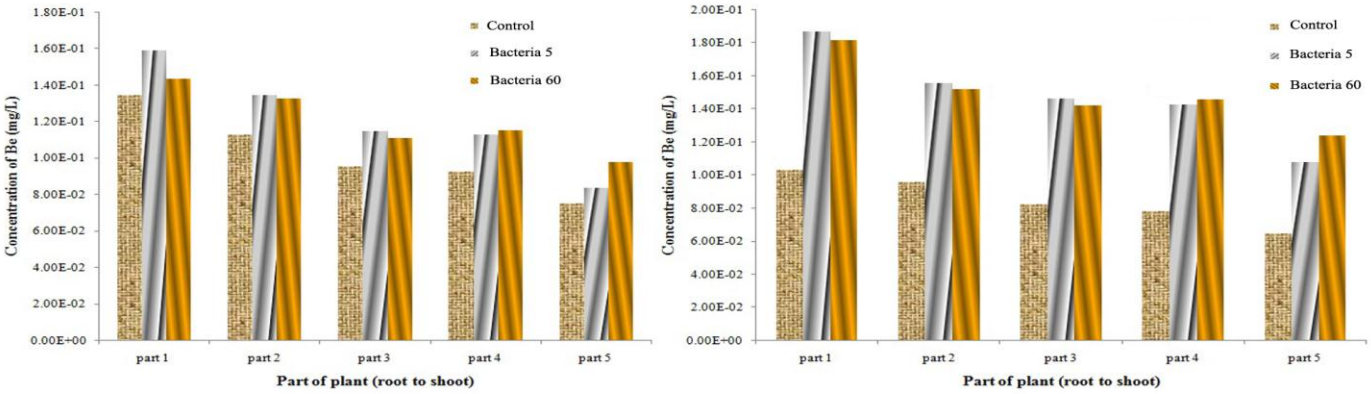
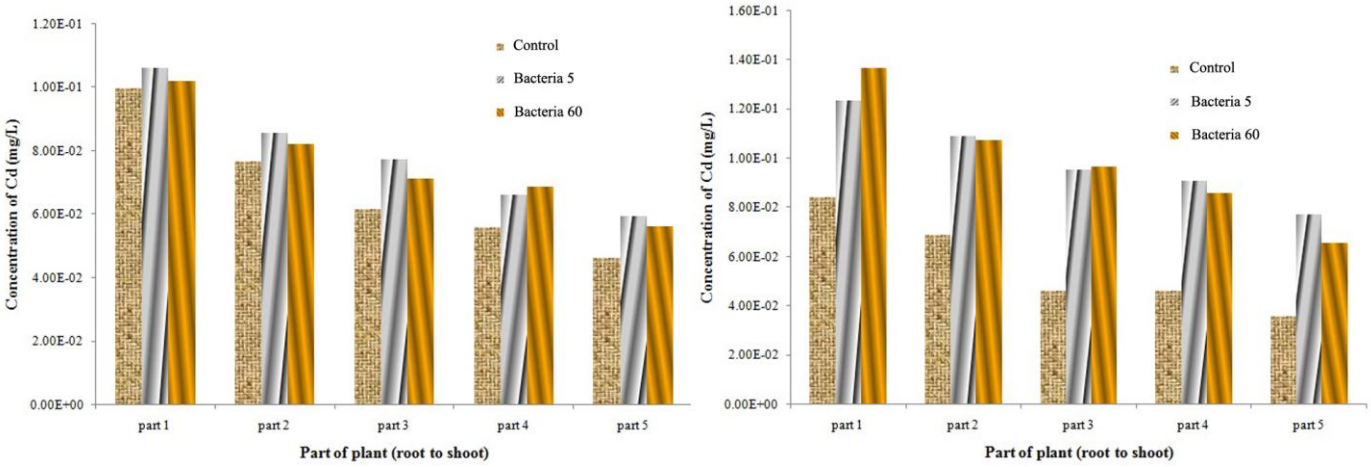


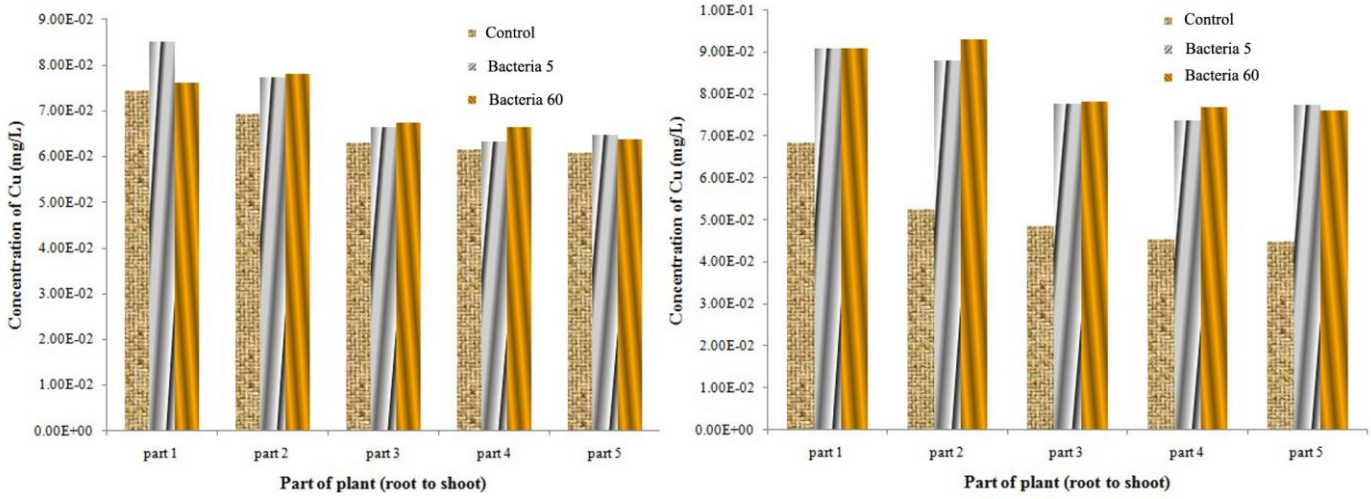
Fig. 2 Concentration of Be in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).



a. Concentration of Cd on 1th day

b. Concentration of Cd on 42th day

Fig. 3 Concentration of Cd in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well



a. Concentration of Cu on 1th day

b. Concentration of Cu on 42th day

Fig. 4 Concentration of Cu in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).

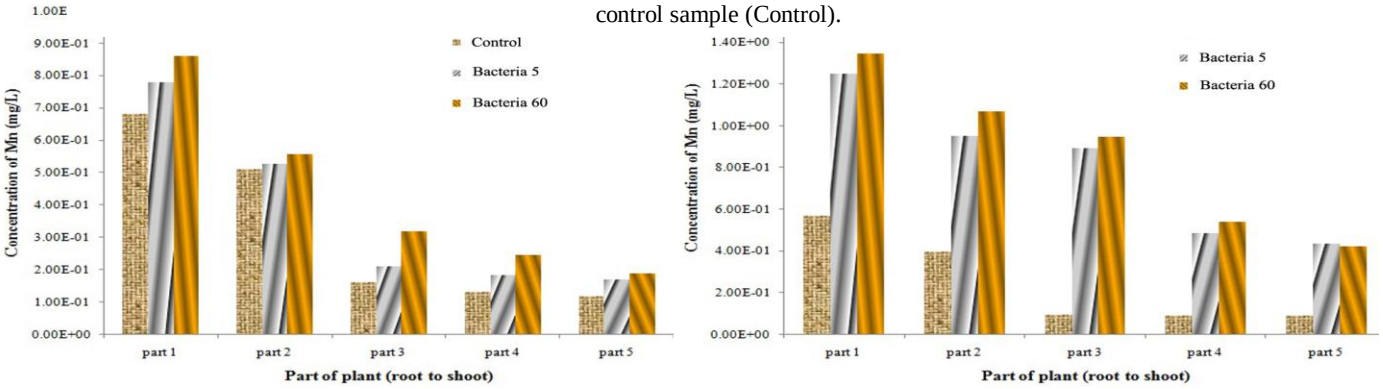
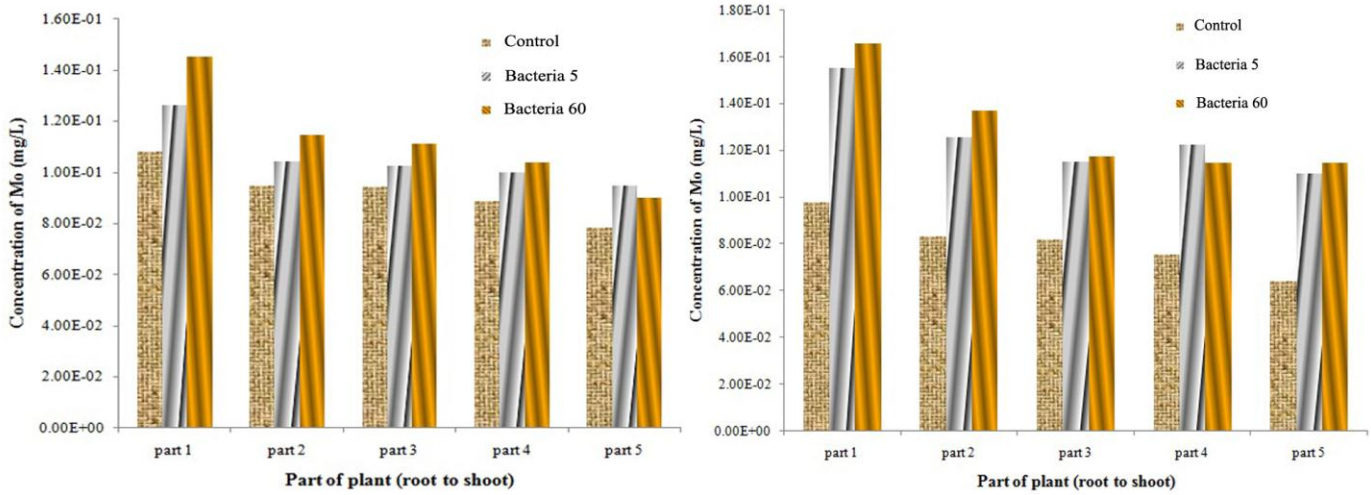


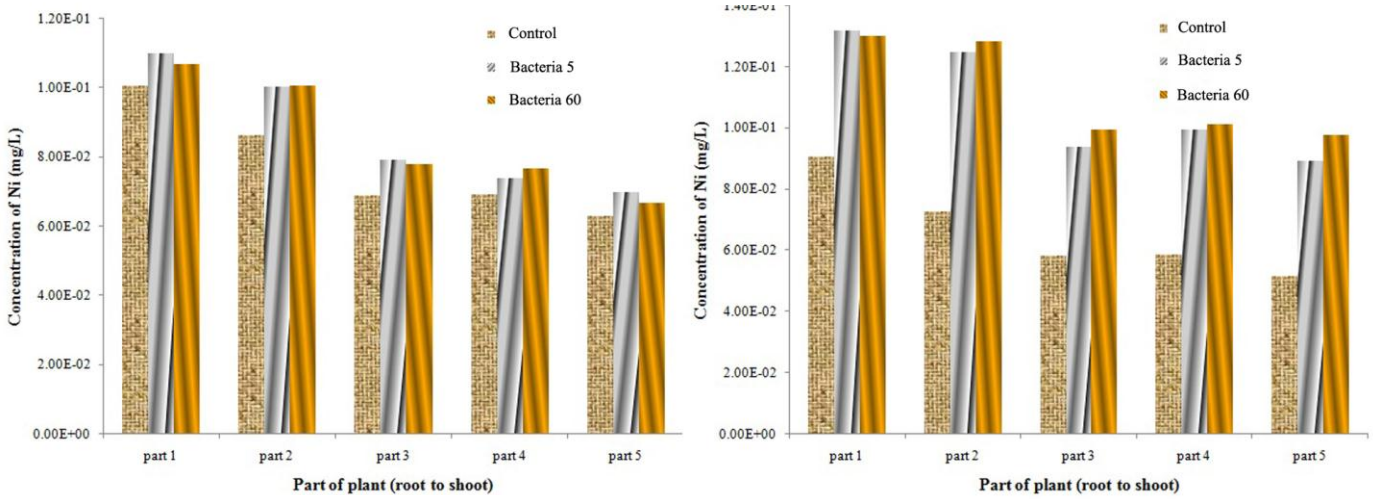
Fig. 5 Concentration of Mn in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).



a. Concentration of Mo on 1th day

b. Concentration of Mo on 42th day

Fig. 6 Concentration of Mo in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).



a. Concentration of Ni on 1th day

b. Concentration of Ni on 42tn day

Fig. 7 Concentration of Ni in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).

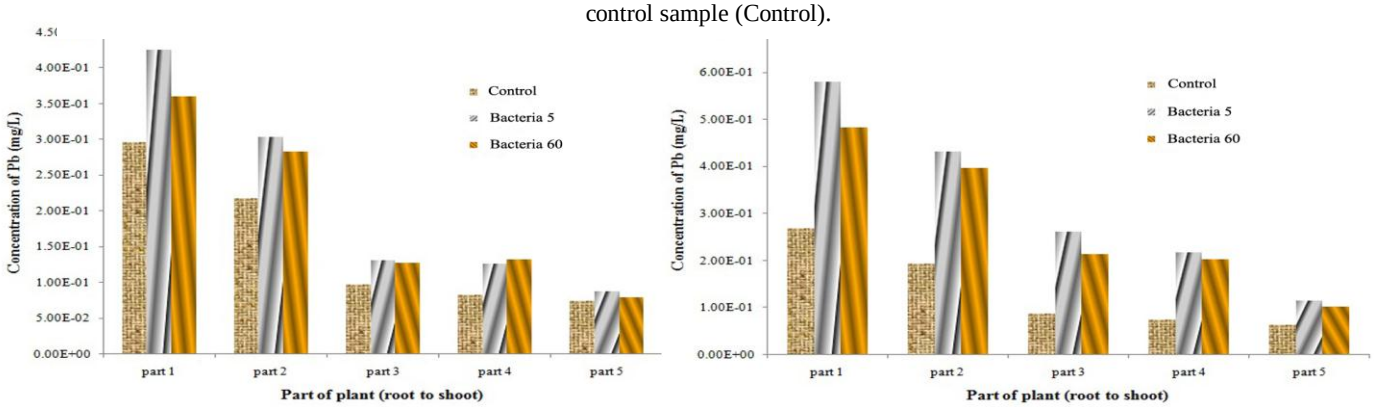
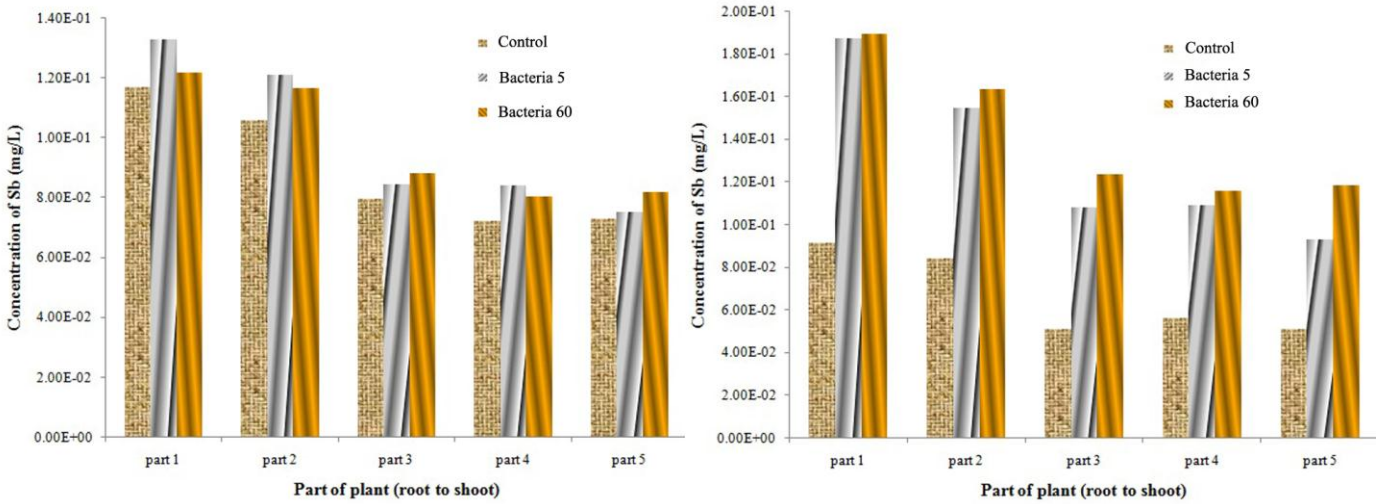
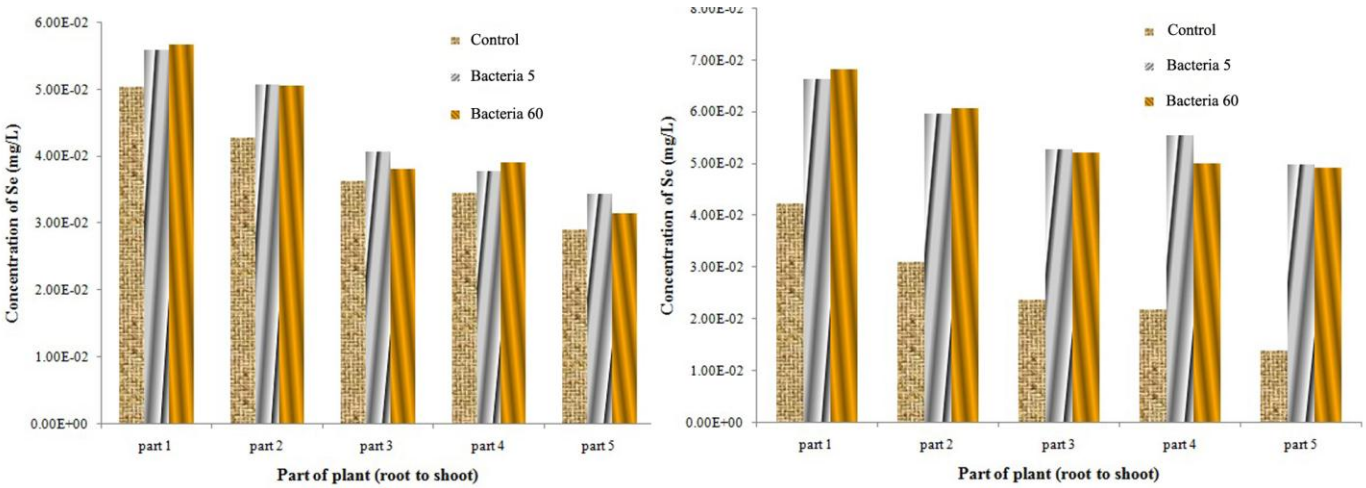


Fig. 8 Concentration of Pb in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).



a. Concentration of Sb on 1st day b. Concentration of Sb on 42nd day

Fig. 9 Concentration of Sb in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).



a. Concentration of Se on 1st day b. Concentration of Se on 42nd day

Fig. 10 Concentration of Se in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).

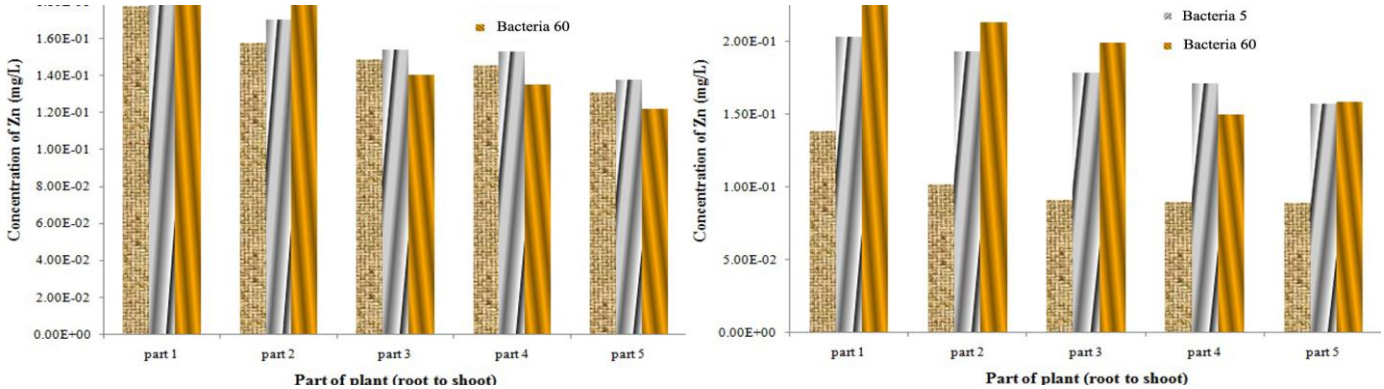


Fig. 11 Concentration of Zn in 5 identical parts of plant sample (*Scirpus mucronatus*) after 1 and 42 days of exposure by bacterial inoculums namely *Brevundimonas diminuta* (bacteria 5) and *Alcaligenes faecalis* (bacteria 60) in Hg contaminated soil, as well control sample (Control).

IV. Conclusion

The effect of two bacterias namely *Brevundimonas diminuta* and *Alcaligenes faecalis* were investigated for plant growth promotion and heavy metal up-taking in Hg soil contaminated. The plant of *Scripus mucronatus* was utilized in present study. The results were shown a good ability to transport toxicity elements of As, Be, Cd, Cu, Mn, Mo, Ni, Pb, Sb, Se, And Zn from soil to plant. The finding was indicated these two bacterias were able to mobilize the heavy metals in the soil contaminated and raise the plant growth promotion. Utilizing of these two bacterias for growing up of this local plant (*Scripus mucronatus*) can be useful and economical to all countries to decrease the toxicity elements from environment.

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