

Rhizobacterium *Enterobacter ludwigii* GAK2 Mitigates Cadmium Toxicity in Rice (*Oryza sativa*) through Silicate and Phosphate Solubilization

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[Introduction]

Silicon (Si) and phosphorus (P) are recognized as key elements that are essential for growth and quality yield of rice plant. Although the earth crust is rich in silicate and phosphate, it exists in insoluble form for plant uptake. Thus, Si and P are supplied externally through fertilizer. However, toxic heavy metal like cadmium (Cd) are exposed in the agriculture land through phosphate fertilizer. Cd exposure in food chain causes phytotoxicity in plant and serious disorder in human health. In recent studies, the Si is reported to mitigate various heavy metal toxicity. Based on these, the current study aimed to minimize fertilizer application through employing silicate and phosphate solubilizing bacteria, to meet Si and P requirement in rice plant under cadmium stress.

[Materials and Methods]

Silicate and phosphate solubilizing rice rhizospheric bacteria that could resist Cd was isolated. The pot experiment was performed by transplanting the two weeks old rice seedling var. Hwayeongbyeon by amending 0.4 g of either Insoluble silicate ($Mg_2O_8Si_3$) or Insoluble phosphate ($Ca_3(PO_4)_2$) in 200 g of sterilized soil. After that, the isolated strain was inoculated. The experiment was designed as **Case I**: Control, Cadmium, **Case II**: No Treatment (NT), IS ($Mg_2O_8Si_3$), IS+GAK2 ($Mg_2O_8Si_3$ + Bacteria), GAK2 (Bacteria only), **Case III**: No Treatment (NT), IP ($Ca_3(PO_4)_2$), IP+GAK2 ($Ca_3(PO_4)_2$ + Bacteria), GAK2 (Bacteria only). Growth promoting attributes of the plants were recorded and bio-chemical analysis was performed.

[Results and Discussion]

The isolated strain was *Enterobacter ludwigii* GAK2 with registered NCBI accession number KP676113. The GAK2 inoculation significantly increased the plant fresh shoot and root weight, plant height and chlorophyll content. The Cd content was found significantly higher in plant shoots without treatment in **Case I**. Whereas, in **Case II** the bacterial inoculation significantly reduced the Cd content on IS + GAK2. Similarly, the Cd content was significantly reduced on IP amended with GAK2 (IP + GAK2) in **Case III**. Moreover, GAK2 inoculation showed higher expression of silicon carrying gene *Lsi1* and lower expression of cadmium carrying gene *OsHMA2* on IS+GAK2. Likewise, the expression of *OsHMA2* was significantly reduced in GAK2 + IP. These results showed that GAK2 inoculation could solubilize Si and P and enhances its uptake, while lower the Cd uptake. Therefore, *Enterobacter ludwigii* GAK2 could be used as Si and P fertilizer to counteract the Cd toxicity in plant.

[Acknowledgement]

This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2016R1D1A3B03931629)

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