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Understanding heavy metal tolerance mechanism in sorghum using proteomics technique

Swapan Kumar Roy[1], Seong-Woo Cho[2], Soo-Jeong Kwon[1], Moon-Soon Lee[3], Zhanguo Xin[4], Hee-Ock Boo[5], Hag-Hyun Kim[6], Yong-Gu Cho[1], Sun-Hee Woo[1*]

[1]Dept. of Crop Science, Chungbuk National University, Cheong-ju 28644, Korea
[2]Dept. of Crop Science and Biotechnology, Chonbuk National University, Jeon-ju 54896, Korea
[3]Dept. of Industrial Plant Science & Technology, Chungbuk National University, Cheong-ju 28644, Korea
[4]Plant Stress and Germplasm Development Unit, USDA-ARS, 3810 4thStreet, Lubbock,TX, USA
[5]WELLPHYTO Co, Ltd., BI Center, GIST, Gwangju 61005, Korea
[6]Dept. of Food Nutrition and Cookery, Woosong College, Daejeon 34606, Korea

[Introduction]

Many abiotic stresses directly or indirectly affect agricultural crops drastically. Among the abiotic stresses, heavy metals (HM) such as cadmium (Cd), and copper (Cu) are thought to be the most detrimental not only reducing plant growth and development but also deteriorating the quality of food. Cropping of *S. bicolor* plants facilitated by agronomic practices may be a sustainable technique for partial decontamination of heavy metal contaminated soils. Heavy metals at toxic levels have the capability to interact with several vital cellular biomolecules such as nuclear proteins and DNA, leading to oxidative stress in plants. Proteomics deals with the study of the large-scale expression of proteins in an organism encoded by its genome. Although genomic analysis has enhanced our understanding regarding plants' response to heavy metal toxicity, transcriptomic changes in the genome are not always reflected at the protein level. Recently, the molecular mechanism for plant interaction with heavy metals has attained considerable interest in the field of metalloproteomic studies.

[Materials and Methods]

The seeds of *Sorghum bicolor* L. (BTX 623) were collected from National Germplasm Resources of USDA-ARS, plant stress and germplasm development unit, USA. Seeds were surface sterilized with 1% NaClO, placed in petri dishes and the seeds were then placed in a petri dish on growth chamber and grown in a controlled environment at 25C with light intensity 8000 Lux and 70% humidity. For Cd and Cu-induced experiments, three replicates each consisting of seven seedlings were included for both control and Cd and Cu treatment. The 10 days old plants were subjected to the nutrient solutions supplied with 0, 100, 150 M CdCl2 and CuSO4 and grown in the same controlled environment and the leaves were harvested after 5 days of Cd and Cu-treatment for the analysis of morpho-physiological and ionic alteration.

[Results and Discussions]

To explore the Cu and Cd tolerance mechanism in Sorghum seedling, the present study was performed. The plant growth characteristics (fresh weight, plant height, shoot length, dry weight) were inhibited compared to control plants under HM stress. The results obtained from the ionic imbalance study revealed that excess HM stress has an adverse effects on up taking others ion under HM stress. Using the 2-DE method, a total of 24 and 21 differentially expressed protein spots from sorghum leaves and roots respectively, 33 protein spots from sorghum leaves under Cd stress were analyzed using MALDI-TOF/TOF MS. However, the over-expression of GAPDH plays a significant role in assisting Sorghum bicolor to attenuate the adverse effects of oxidative stress caused by Cu, and the proteins involved in resistance to stress helped the sorghum plants to tolerate high levels of Cu. Significant changes were absorbed in the levels of proteins known to be involved in carbohydrate metabolism, transcriptional regulation, translation and stress responses. In addition, the up-regulation of glutathione S-transferase and cytochrome P450 may play a significant role in Cd-related toxicity and stress responses. Taken together, the results suggest that photosynthesis and energy metabolism was inhibited under oxidative stress and the over-expression of GAPDH plays a major role in assisting *S. bicolor* to attenuate the negative effects of oxidative stress caused by HM stress.

*Corresponding author: Tel. +82-43-261-2515, E-mail. shwoo@chungbuk.ac.kr