Alleviation of exogenous silicon on cadmium toxicity in mangrove *Avicennia marina* (Forsk.) Vierh in relation to the distribution of cadmium compartmentation

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Mangroves are distributed at tropical and subtropical estuaries and coastal intertidal areas, which have specific adaptive mechanisms of physiological, morphological, anatomical and molecular characters due to the harsh tidal conditions. Some mangrove species seem to be highly tolerant of heavy metal pollution. Silicon (Si) is the second most abundant element in the terrestrial crust and soils, and is the mineral matrix of growth for most plants. There is increasing evidence that Si has been beneficial for the healthy growth and development of many plant species. The relationship between Si and resistance of plants to toxic metals has been extensively studied. The objective of this study was to investigate whether or not Si has ameliorated the toxic effects of Cd and affected Cd subcellular distribution in the leaves and the root tips of *Avicennia marina* (Forsk.) Vierh. The results showed that Si partly overcame the reduction in growth due to Cd. This amelioration was correlated with a reduction in Cd uptake and alteration of Cd subcellular distribution. The mechanisms of Si amelioration of Cd stress were tissue dependent. In the leaves and the root tips, Si reduced Cd concentration in subcellular fractions and Cd mobility and the concentration of biologically active Cd in the cell walls active space. Si did not change the distribution ratio of Cd compartmentation in the leaves, but increased the ratio of Cd in the cell walls and reduced the ratio of Cd in the symplast of the root tips. Si plays an important role in alleviating the toxicity of Cd in *A. marina* seedlings. Si decreased the total concentration of Cd in the leaves and in its root tips. Si treatment did not change the distribution ratio of Cd compartmentation in the leaves, but reduced Cd mobility and the concentration of biologically active Cd in the cell walls active space. In the root tips, Si restricts the apoplastic transport of Cd through the enhanced absorption of Cd on the cell walls, resulting in reduction of the ratio of Cd in the symplast and alleviation of Cd toxicity to the cytoplasm. The Si-mediated reduction of Cd concentration and Cd binding properties of the cell walls in the leaves and the root tips might be responsible for the role of Si in alleviating Cd toxicity to *A. marina* seedlings. Changes to the distribution ratio of Cd compartmentation may be an important mechanism of Si-induced Cd tolerance for *A. marina* seedlings in the root tips.

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Corncob hydrolysate, highly efficient substrate of submerged fermentation for Monascus pigment production

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Monascus pigment is traditionally produced by Monascus fermentation employing rice powder or glucose as the culture substrate. By submerged fermentation, Monascus pigment yield would be more stable and the accompanied toxic byproduct-citrinin could be controlled and removed more easily. To reduce the cost of Monascus submerged fermentation, the feasibility of corncob hydrolysate as an alternative substrate was investigated. Results showed that, compared to the traditional glucose medium, corncob hydrolysate medium had an equal pigment yield without stimulating accumulations of the toxic citrinin. Further more, the corncob hydrolysate medium and cultivation were optimized to enhance pigment productions but depress synthesis of the toxic citrinin. When Monascus was cultured under dark condition and caprylic acid was added into the medium, the pigment was increased to 25.81±0.83 UA500/mL, higher than 24.04±0.97 UA500/mL of the glucose medium and previously reported yields in Monascus submerged fermentation based on the same yield unit, and the toxic citrinin was decreased to 26.2±1.9 μg/L, significantly lower than 44.3±2.2 μg/L of the glucose control and that reported in publications. In this study, corncob hydrolysate was proved to be safe and highly efficient alternative substrate of submerged fermentation for Monascus pigment productions, which showed significant advantages than the traditional glucose substrate.

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