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Generation of cadmium tolerant plants by manipulating Ub/26S proteasome-dependent proteolysis

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The Ub/26S proteasome system removes abnormal proteins and most short-lived regulatory proteins, thereby contributing to cell proliferation, hormone responses, development and resistance to abiotic and biotic stresses. Cadmium reduces enzyme activities and disrupts protein structures, and Ub-dependent proteolysis seems to play a role in Cd tolerance in yeasts, although no direct relationship between the two phenomena has been demonstrated. In addition, the involvement of Ub-dependent proteolysis in Cd tolerance has not been proved in animals and plants. Here we show that Cd tolerance is proportional to 26S proteasome activity, implying that Ub-dependent proteolysis is directly involved in Cd tolerance in plants. Over-expression of *NtUBQ2* (the Ub-extension protein) or *NtUBC2* (the Ub-conjugating enzyme) increased Cd tolerance by enhancing proteasome activity in response to Cd in transgenic tobacco. However, anti-sense *NtUBQ2* transgenic tobacco showed severe growth retardation even in control conditions. These observations suggest that plants acquire cadmium tolerance by removing cadmium-induced denatured proteins via Ub/26S proteasome-dependent proteolysis. This finding could be applied to engineering efficient metal-phytoremediators.

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