relationship between them and rhizogenesis remains obscure and needs to be studied further.

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ENHANCED CERIUM CONCENTRATION IN MAGNESIUM-DEFICIENT PLANTS

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MONAZITE, found in the coastal belt of tropical countries, is rich in elements like thorium and cerium. We had reported elevated levels of thorium in cardiac tissue samples of patients with endomyocardial fibrosis, a tropical cardiomyopathy, and postulated that the disease may be the 'cardiac expression of an elemental interaction that causes a toxic metal to replace or displace an essential element at the cellular level'[1]. Subsequent studies[2] have shown that the levels of cerium in the cardiac tissue samples are higher than those of thorium in endomyocardial fibrosis. Since the higher tissue levels of thorium and cerium coexist with a relative decrease in the concentration of magnesium, it is possible that the deficiency of magnesium might enhance the levels of these toxic elements. As tuber crops in Kerala have been reported to have high concentrations of monazite elements like thorium[3], an experimental study was undertaken to determine whether the deficiency of magnesium might promote the concentration of cerium in a tuber crop, *Coleus parviflorus*, grown in culture.

Coleus parviflorus was grown in Murashige and Skoog medium containing 1 μM benzyladenine, 1 μM naphthaleneacetic acid and 0.8% agar[4]. Magnesium-deficient medium was obtained from Hi-Media (Bombay, India), and the required amount of magnesium added to it. The normal medium (A) contained 180.8 mg/l $MgSO_4$ (anhydrous) and the

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Table 1 *Magnesium and cerium concentrations in Coleus parviflorus grown in medium containing normal and lower concentrations of magnesium*

	Elemental estimations in plants			
	2 Weeks		4 Weeks	
Conc. in medium ($MgSO_4$-anhydrous)	Mg. mg/g wet wt $\mu \pm SD$, $n=3$	Ce. ng/g wet wt $\mu \pm SD$, $n=3$	Mg. mg/g wet wt $\mu \pm SD$, $n=3$	Ce. ng/g wet wt $\mu \pm SD$, $n=3$
A (180.8 mg/l)	0.107 ± 0.021	56.90 ± 23.32	0.073 ± 0.015	106.50 ± 10.47
B (90.4 mg/l)	0.173 ± 0.035	92.87 ± 57.45	0.053 ± 0.006	273.67 ± 41.63
t-value	3.96*	1.02	3.03*	9.54**

*$P<0.05$; **$P<0.01$.

medium with lower level of magnesium (B) contained 90.4 mg/l $MgSO_4$ (anhydrous). Cerium sulphate (1.5 mg/l) was added to media A and B and pH adjusted to 5.4. Culture tubes containing 15 ml of medium were sterilized and one shoot-tip was inoculated in each tube. Fifty tubes of each of the two groups were prepared. After 2 weeks in culture, 24 plants from each of the two groups were removed and their base cut at the level of the medium. Four randomly taken plants were pooled and the wet weights recorded. The plants were rinsed thrice in triple-distilled water and dried in preweighed containers at 80°C for 4 days, by which time constancy in dry weight was obtained. The levels of magnesium in the plants were estimated by atomic absorption spectrophotometry. Cerium levels were estimated by neutron activation analysis[5]. The same procedure was repeated at the end of 4 weeks for the remaining plants of the two groups. Six samples were obtained for each group at a time, three of which were used for estimation of magnesium and three for estimation of cerium.

The results of the analysis (table 1) show that, after 2 weeks in culture, the mean level of cerium in plants of group B (92.87 ± 57.45 ng/g wet wt) was higher than that of group A (56.90 ± 23.32 ng/g wet wt). At the end of 4 weeks the levels increased further (106.5 ± 10.47 and 273.67 ± 41.63 ng/g wet wt respectively for groups A and B), the difference being statistically significant ($t=9.54$, $P<0.01$). At the end of two weeks the magnesium level in plants of group B (0.173 ± 0.035 mg/g wet wt) was significantly higher compared to that of group A (0.107 ± 0.021 mg/g), but by 4 weeks, the magnesium levels had decreased, that in group B (0.053 ± 0.006 mg/g) being significantly lower than that in group A (0.073 ± 0.015 mg/g).

The data on the levels of cerium indicate that they are enhanced by magnesium deficiency in the medium, which is also reflected in the levels of magnesium in the plants. While the exact mechanism for this elemental interaction remains unclear, it is possible that cerium competes with magnesium for naturally occurring chelators and forms irreversible bonds with them. Such mechanisms are well known in biological systems, as exemplified by the interactions of magnesium and aluminium[6] and of cadmium with other metals[7]. Our observations in this study could have significance in relation to the geochemical basis of endomyocardial fibrosis.

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