Effects of Fifteen Rare-Earth Metals on Ca^{2+} Influx in Tobacco Cells

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Effects of naturally existing rare-earth metals (REMs; atomic numbers, 39, 57–60, 62–71; Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu), added as chloride salts, on Ca^{2+} influx induced by two different stimuli, namely hypoosmotic shock and hydrogen peroxide, were examined in a suspension-cultured transgenic cell line of BY-2 tobacco cells expressing aequorin, a Ca^{2+}-sensitive luminescent protein in cytosol. Most REM salts used here showed inhibitory effect against Ca^{2+} influx. Especially $NdCl_3$, $SmCl_3$, $EuCl_3$, $GdCl_3$ and $TbCl_3$ showed the most robust inhibitory action. In contrast, $LuCl_3$, $YbCl_3$, $ErCl_3$ and YCl_3 were shown to be poor inhibitors of Ca^{2+} influx. Since REMs tested here form a sequential range of ionic radii from 86.1 to 103.2 pm and the optimal range of ionic radii required for blocking the flux of Ca^{2+} was determined for each stimulus. The hydrogen peroxide-induced Ca^{2+} influx was optimally blocked by REMs with a broad range of ionic radii (93.8–101 pm) which is slightly smaller than or similar to that of Ca^{2+} (100 pm), while the hypoosmotically induced flux of Ca^{2+} was inhibited optimally by few REMs with a narrower range of relatively smaller ionic radii around that of Gd^{3+} (93.8 pm) a well known inhibitor of stretch-activated channels. Possible applications of such series of channel blockers in elucidation of plant signal transduction pathways are encouraged.

Key words: Calcium, Ion Channel, Ionic Radius, Rare-Earth Elements