Net nitrate uptake, PM H+-ATPase activity and related gene expressions in maize roots in response to coumarin

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Abstract

Coumarin is the most simple plant secondary metabolite widely distributed in plant kingdom affecting root form and function, including anatomy, morphology and nutrient uptake. A physiological and molecular approach in maize roots exposed to different coumarin concentrations, with or without 0.2 μM nitrate (NO3-), was adopted to elucidate its mode of action. In particular, the time course of net NO3- uptake rate (NNUR), PM H+-ATPase activity, proton pumping, and related gene expressions (*ZmNPF6.3*, *ZmNRT2.1*, *ZmMHA3* and *ZmMHA4*) were evaluated. Coumarin alone did not affect NNUR, PM H+-ATPase activity and transcript levels of *ZmNRT2.1* and *ZmMHA3*. By contrast, coumarin alone increased *ZmNPF6.3* and *ZmMHA3* expression, as observed in response to abiotic stress. When coumarin and NO3- were concurrently added to the nutrient solution, an increase in NNUR, PM H+-ATPase activity together with *ZmNRT2.1* and *ZmMHA3* expression levels were observed, suggesting that coumarin affected the inducible component of high affinity transport system (iHATS) of NNUR and this effect was probably mediated by nitrate. Indeed, as the energy conditions were favourable in terms of PM H+-ATPase, the active proton pumping became essential for nitrate uptake. Moreover, the results with vanadate, an inhibitor of PM H+-ATPase, suggested that this enzyme could be a main target of coumarin. Surprisingly, coumarin did not affect the H+-ATPase activity by direct contact with plasma membrane vesicle isolated from maize roots, indicating its possible role in the transcription processes as well.

Keywords: coumarin, nitrate uptake, H+, ATPAse

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