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Implications of Oxidative Stress for Monoterpenoid Oxindole Alkaloid Production in Uncaria tomentosa Cultures

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Abstract : The conditions of biotic and abiotic stress in plants can lead to the generation of high amounts of reactive oxygen species (ROS), which leads through a signaling cascade and second messengers to different antioxidant defense responses including the production of secondary metabolites. A limited number of species of plants like Uncaria tomentosa (cat claw) typical of the Amazon region produce monoterpenoid oxindole alkaloids (MOA) such as isopteropodine, mitraphylline, rhynchophylline and its isomers. Moreover, in cultivated roots, the glucoindole alkaloid 3α-dihydrocadambine (DHC) is also accumulated. Several studies have demonstrated that MAO has antioxidant properties and possess important pharmacological activities such as antitumor and immunostimulant while DHC, has hypotensive and hypolipidemic effects. In order the study the regulatory concerns operating in MAO production, the links between oxidative stress and antioxidant alkaloid production in U. tomentosa root cultures were examined. Different amount of hydrogen peroxide between 0.2 -1.0 mM was added to 12 days old roots cultures showing that, this substance had a differential effect on the production of DHC and MOA whereas the viability remained in 80% after six days. Addition of 0.2 mM hydrogen peroxide increased approximately 65% MAO and DHC production (0,540 ± 0.018 and 0.618 ± 0.029 mg per g dry weight, respectively) relative to the control. On contrast, after the addition of 0.6 mM and 1 mM hydrogen peroxide, DHC accumulation into the roots gradually decreased to 53% and 93% respectively, without changes in MAO concentration, which was in relation to a twice increase of the intracellular hydrogen peroxide content. On the other hand, concentrations of DHC (0.1, 0.5 and 1.0 mM in methanol) demonstrated free-radical scavenging activity against 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. The calculated IC50 for all tested concentrations was 0.180 mg per ml (0.33 mM) while the calculated TE50 was 276 minutes. Our results suggest that U. tomentosa root cultures both MAO and DHC have antioxidant capacities and respond to oxidative stress with a stimulation of their production; however, in presence of a higher concentration of ROS into the roots, DHC could be oxidized.

Keywords : monoterpenoid indole alkaloid, oxidative stress, root cultures, uncaria tomentosa
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