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Biochemical Responses of Aquatic Macrophytes against Mechanical Stress of Water Turbulence

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Abstract

Aquatic plants face an array of stresses within the environment, while the water movements play a significant role in this regard. Although, velocity of flow and water level fluctuations has been extensively studied, turbulence driven impacts are yet to be explored. Thus, this study evaluated the turbulence induced stress response of aquatic macrophytes in a small shallow stream, Moto Arakawa, a tributary of the Arakawa River, Japan. Velocity fluctuations in macrophyte patches were measured in six sites (L1-L6) using a two dimensional electromagnetic current meter. After measuring flow velocity, plant samples were collected for biochemical analysis. Fresh plant shoots were extracted either by using an ice cold phosphate buffer that contained polyvinylpyrrolidone or distilled water. Biochemical assay was performed using the antioxidant activity of Catalase (CAT), Ascorbic Peroxidase (APX), concentrations of H_2O_2 and Indole Acetic Acid (IAA) following the standard methods. In terms of turbulence velocity, these sites were significantly different from each other ($p < 0.05$). Except L1, water turbulence was comparatively higher in outside of the plant patches than that of inside. Four macrophyte species were found in study sites, *Myriophyllum spicatum*, *Elodea nuttallii*, *Spaganium erectum* and *Vallisneria spiralis*. Antioxidant productions were significantly higher in plants exposed to high turbulence and the responses of plants against turbulence were species specific. For example, *E. nuttallii* showed comparatively high concentration of H_2O_2 compared to other species, within the same site. Further, CAT activity of *E. nuttallii* was also higher than that of *M. spicatum*. The most common species; *M. spicatum* exhibited significant correlations with the turbulence and antioxidant enzymes APX ($r^2 = 0.76$, $p < 0.05$). Similarly, the linear relationship between H_2O_2 production was positively correlated to the turbulence ($r^2 = 0.70$ $p < 0.05$) while it was negative for IAA production ($r^2 = -0.73$, $p < 0.05$). Present study revealed that, water turbulence causes a significant impact on aquatic plants as an abiotic stress factor.

Keywords: *Water movements, Mechanical stress, Antioxidant enzymes, H_2O_2*
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