Title : Image Processing-Based Analysis of Morphological Changes in *Pediastrum duplex* Under Copper Sulfate Stress.

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ABSTRACT

Heavy metal contamination in aquatic environments, primarily from industrial and agricultural activities, poses a significant threat to ecosystems, especially heavy metals contamination. Algae are widely used as bioindicators due to their high sensitivity to pollutants, rapid response to environmental changes, and ease of cultivation. Monitoring algal morphological and physiological changes can provide valuable insights into metal toxicity. This study investigated the morphological changes in *Pediastrum duplex* under copper sulfate ($CuSO_4$) stress using image processing techniques. Algal cells were exposed to $CuSO_4$ at concentration of 0.5, 0.75, 1.0, 1.25, and 1.5 mg/L. with significant reductions in cell density observed at 0.75 and 1.0 mg/L compared to the control. These concentrations were further analyzed using image processing to assess morphological alterations. The image processing technique exhibited a high average accuracy of 0.9, confirming its effectiveness in detecting cell structure changes. However, precise determination of heavy metal exposure levels and standardized criteria for identifying abnormal algal cells are essential to minimize misclassification and enhance analytical reliability.

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