**Melatonin and microbial fortification improved photosynthetic efficiency and phenolic contents in *Brassica juncea* L. plants under Cd stress**

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**Abstract**

The contamination of soil with cadmium (Cd) has become a serious environmental issue. Plants under cadmium stress have a decrease in biomass and photosynthetic rate. According to Voigt and Nagel (2002), cadmium can also impede the water-splitting complex of PS II's oxidizing site (Nirupama and Mohn 2003), stop photosynthetic electron transport, or competitively bind to PSII's critical $Ca^{2+}$ site during photoactivation (Faller et al., 2005). Osmopriming with Mlt improves photosynthesis and modulates expression of key photosynthetic genes. Plant Growth-Promoting Rhizobacteria (PGPR) are a helpful species of bacteria that are found among rhizobacteria. Plant roots can be colonized by PGPR, which can also greatly improve soil fertility, encourage plant growth and development, and raise crop output. The current study's goal was to evaluate the impact of Cd toxicity on *Brassica juncea* L. and to unriddle the ameliorative potential of phytohormone, Melatonin (Mlt) mediated plant-microbe (*Pseudomonas putida* (Pp), *Pseudomonas fluorescence* (Pf)) interaction in *B. juncea* L. The largest significant increase in total chlorophyll, carotenoids, xanthophyll, anthocyanin, and flavonoid content was found with Mlt and PpPf treatment in Cd stressed *B. juncea* seedlings, which is in corroboration with spectrophotometric analysis. Furthermore, scanning electron microscopy (SEM) analysis of the abaxial surface of leaves showed enhanced stomatal size and density under treatments of ameliorators when compared to Cd stressed seedlings. Using confocal microscopy, autofluorescence imaging of photosynthetic pigments such as chlorophyll, carotenoids, and total phenols revealed that Mlt and PpPf exhibited the highest fluorescence. Also, application of Mlt and PGPR improved gene expression of key photosynthetic genes (psb A for D1 subunit PSII, psb B for CP 47 subunit of PSII, CHS for chalcone synthase, PAL for phenylalanine ammonialyase, PSY for phyotene synthase). Hence, current study recommends that dual application of Mlt and PGPR can reduce Cd induced toxicity in *B. juncea* seedlings.