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Effect of cadmium ions on pigment synthesis in *Phaseolus aureus*

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Abstract

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The influence of a wide range of $CdCl_2$ concentrations on the synthesis of photosynthetic pigments was studied in *Phaseolus aureus* Roxb. CV PS16. Total chlorophylls (Chl) and carotenoids (Car) levels were decreased by $CdCl_2$ treatments. Chl *a*/*b* ratio decreased with increased $CdCl_2$ concentrations, indicating a more pronounced inhibitory effect of Cd on Chl *a* than on Chl *b* synthesis. A decrease in Car/Chl ratio was observed contrary to earlier observations in some fresh water algae.

Introduction

Cadmium is a major environmental pollutant. The sources of Cd pollution include motor vehicle exhausts, smelters, fertilizers and industries (Lagerwerff 1967, Buchauer 1973, Foy et al. 1978). Cd is absorbed by the plant either through roots or leaves. Foliar absorption has been reported in plants growing near smelters (Buchauer 1973). The physiological aspects including photosynthesis, respiration and nitrate metabolism under Cd stress were studied either in detached leaves or in isolated organelles (Miller et al. 1973, Bazzaz and Govindjee 1974, Bazzaz et al. 1974, Venkatramana et al. 1978, Woolhouse 1983). Little information is available on Cd influence on pigment synthesis in higher plants. Hence the present study.

Materials and methods

Ph. aureus Roxb CV PS16 plants were grown in darkness on moistened filter paper in petri dishes at 27±2 °C. Pigment synthesis was studied according to Hampp and Lendzian (1972) in leaf disks taken from the first pair of etiolated leaves of one week old seedlings. 25 diks (5 mm) for each treatment were kept in cadmium chloride solutions at 27±2 °C under a bank of fluorescent lamps with an intensity of 90 W-m^{-2} (LiCor Light meter), with constant shaking. Total chlorophyll (Chl) content and Chl a/b ratio were determined spectrophotometrically in 80% acetone extract using an Elico model CL-24 spectrophotometer according to Arnon (1949). Carotenoids (Car) were estimated by measuring absorbance at 442 nm according to Liaaen-Jensen and Jensen (1971).

Table 1. Total chlorophyll (Chl) and carotenoid (Car) contents, Chl a/b and Car/Chl ratios in control and Cd treated leaf disks of *Ph. aureus* (mg kg^{-1} fr.w.) during 24 or 48 h greening.

Treatments m Eq l^{-1} Cd	24 h				48 h			
	Chl	Car	Chl a/b	Car/Chl	Chl	Car	Chl a/b	Car/Chl
Control	365±1.2	284±1.4	1.24	0.77	384±4.2	444±6.2	1.23	1.15
0.01	352±1.1	275±1.3	1.04	0.78	365±5.7	355±5.5	1.40	0.97
0.1	342±2.0	201±2.0	1.03	0.58	204±4.9	270±4.5	1.00	1.32
1.0	280±1.2	189±2.2	0.92	0.67	180±3.6	207±5.2	0.83	1.15
3.0	254±1.3	123±1.0	0.86	0.48	146±4.1	140±3.1	0.81	0.95
5.0	210±1.2	62±1.1	0.85	0.29	126±2.7	91±1.0	0.56	0.71
10.0	183±0.2	39±1.0	0.56	0.21	102±1.9	64±1.1	0.80	0.63

Results and discussion

Cd inhibition of photochemical reactions of chloroplasts (Bazzaz and Govindjee 1972) reveals that the site of affinity for Cd in chloroplasts includes the thylakoid membrane system (Sabnis et al. 1969). The synthesis and localization of Chl and Car on the thylakoids of chloroplasts is well documented in the literature. Hence Cd may interfere in pigment synthesis by inhibiting the reductive steps in the biosynthetic pathway resulting in reduced levels of pigments in Cd treated leaf disks (Tab. 1).

The decrease in Chl/ab ratio in Cd treated leaf disks suggests that Chl *a* synthesis is more inhibited than Chl *b*. However Hampp and Lendzian (1972) have reported an increase in Chl a/b ratio in Pb treated leaves during greening. In *Euglena* cells de Filippis et al. (1981) have reported a decrease in Chl a/b ratio and an increase in Car/Chl ratio under Zn, Hg or Cd stress. In the present study the decrease in Car/Chl ratio, despite dark accumulation of Car in small quantities suggests a higher inhibitory effect of Cd on Car synthesis than on Chl synthesis.

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