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BRIEF COMMUNICATION

The effects of gibberellic acid on photosynthetic pigments and oxygen evolution in *Chlamydomonas* and *Anacystis*

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Abstract

Gibberellic acid (GA_3) generally increased the contents of chlorophyll but not carotenoid in both *Chlamydomonas reinhardii* and *Anacystis nidulans* grown under continuous irradiation. The photosynthetic oxygen evolution of the algae was also affected by GA_3 except for the high (100 μM) concentration of GA_3.

Exogenous application of gibberellic acid (GA_3) stimulates photosynthetic characteristics in some plant species (Lester *et al.* 1972, Bata and Neskovic 1974, Little and Loach 1975, Starck *et al.* 1980, Foltinová 1987) but not in others (Szalai 1968, Straub and Lichtenthaler 1973, Robinson *et al.* 1978). This is why we tested the effects of GA_3 on the photosynthetic characteristics in *Chlamydomonas* and *Anacystis*.

The cultures of *Chlamydomonas reinhardii* Dang. (*Chlorophyceae*) and *Anacystis nidulans* Richt. (*Cyanophyceae*) were obtained from the Biological Research Center of the Hungarian Academy of Sciences (Szeged). *C. reinhardii* was grown in the TAP medium (Gorman and Levine 1965), *A. nidulans* in the ASM medium (Borcakli 1986). The cultures were grown at 30-35 °C on a shaker under continuous irradiation (130 W m^{-2}) for 2 d (*Chlamydomonas*) or 6 d (*Anacystis*); then the experiment started. We replicated the experiment at least four times starting always with equal number of cells. For this purpose, the cell number was counted by a hemocytometer (*Chlamydomonas*, $5x10^5$ (cell) cm^{-3}) or by a turbidimetric method (*Anacystis*, A_{560}: 0.20) (Borcakli 1986).

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Under sterile conditions, GA_3 was applied to the cultures at 0, 5, 25, 50 and 100 μM concentrations and the tested characteristics were measured after 1, 2 and 3 d. Contents of chlorophyll (Chl) and carotenoids (Car) in 80 % acetone extracts of the algae were measured spectrophotometrically according to Arnon (1949) and Jaspars (1965), respectively.

Table 1. The effects of gibberellic acid (GA_3) on the content of photosynthetic pigments in *Chlamydomonas* and *Anacystis*. Within columns, the data followed by the same letter are not significantly different at 5 % level (Duncan's Multiple Range Test).

Alga	Time [d]	GA_3 [μM]	The content of pigments [μg cm^{-3} (algae suspension)] chl *a*	chl *b*	car
Chlamydo-monas	1	0	5.64 a	3.71 a	0.82 a
		5	6.67 bc	4.35 bc	0.94 a
		25	6.91 c	4.42 c	1.02 a
		50	6.35 bc	4.07 abc	0.98 a
		100	6.16 ab	3.87 ab	0.99 a
	2	0	8.65 a	5.56 a	1.38 a
		5	10.69 b	7.46 b	1.47 a
		25	10.55 b	7.09 b	1.86 a
		50	10.45 b	6.93 b	1.45 a
		100	7.46 a	4.78 a	1.18 a
	3	0	10.75 a	7.11 a	1.80 a
		5	12.34 b	8.17 c	1.52 a
		25	13.20 c	8.03 bc	1.97 a
		50	13.20 c	8.61 c	1.94 a
		100	11.73 b	7.52 ab	1.72 a
Anacystis	1	0	0.34 a		0.15 a
		5	0.63 b		0.21 a
		25	0.84 c		0.26 a
		50	0.68 b		0.25 a
		100	0.86 c		0.25 a
	2	0	0.58 a		0.19 a
		5	0.88 b		0.22 a
		25	1.29 d		0.31 ab
		50	0.81 b		0.28 ab
		100	1.00 c		0.35 b
	3	0	0.80 a		0.29 a
		5	1.03 b		0.34 a
		25	1.14 c		0.33 a
		50	1.15 c		0.36 a
		100	1.15 c		0.38 a

Photosynthetic oxygen evolution of both algae was measured by a modified Clark type oxygen electrode at 25 °C under an irradiance of 350 W m^{-2} after the incubation of the cells for 5 min in the dark (Samuelsson *et al.* 1985).

For all the growth days, 5, 25 and 50 μM GA_3 increased the contents of Chl *a* and *b* in both *Chlamydomonas* and *Anacystis* (Table 1); the differences in Car content were not statistically significant.

Except for the first day, 25 and 50 μM GA_3 increased the photosynthetic oxygen evolution (P_N) of *Chlamydomonas* (Fig. 1, top). The lowest (5 μM) and the highest (100 μM) concentrations of GA_3 did not significantly affect P_N of *Chlamydomonas* (Fig. 1).

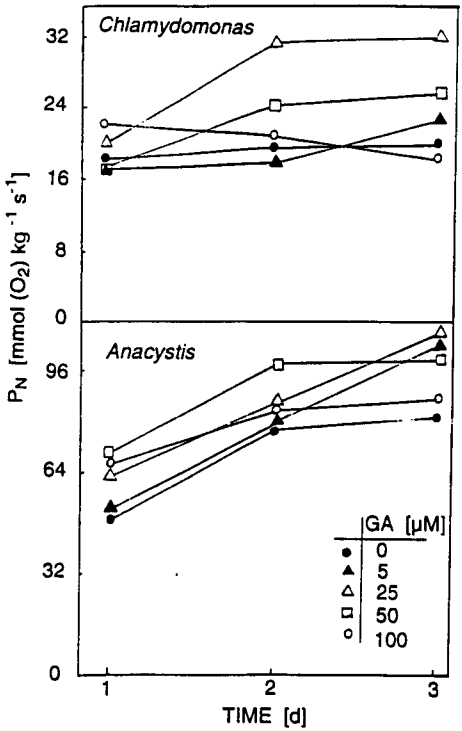

Fig. 1. The effects of GA_3 on the oxygen evolution (P_N) in *Chlamydomonas* and *Anacystis*.L.S.D. (5 %) values (between treatments) for *Chlamydomonas*: 7.8 (1-d), 5.6 (2-d), 5.5 (3-d) and for *Anacystis* 9.5 (1-d), 10.7 (2-d),12.1 (3-d).

In *Anacystis*, all GA_3 concentrations stimulated P_N. At the third day, the 5 and 25 μM GA_3 concentrations induced the most effective P_N stimulation.

Our results show, similarly to those of Foltinová (1987), that low GA_3 concentrations stimulate photosynthetic characteristics of algae, while high GA_3 concenrations may function as inhibitors. According to Whyte and Luckwill (1966) and Bata and Neskovic (1974) GA_3 retards senescence of the photosynthetic

apparatus and in this way it may control pigment contents and photosynthetic activity.

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