The Effects of Various Aroclor Fractions on the Productivity of *Chlorella pyrenoidosa*

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Introduction

HAWES et.al., (in press) demonstrated that polychlorinated biphenyls (PCBs) exert temporary depressing effects on the laboratory population growth of Chlorella pyrenoidosa, a common species of green freshwater algae. These effects were dose-related and apparent at concentrations of 100 ppb and 1 ppm. Concurrent studies investigated the effects of several Aroclor fractions on the primary productivity of Chlorella. This paper reports these results and correlates the data to the population growth studies.

Methods

Cultures of Chlorella pyrenoidosa were maintained as described by HAWES et.al.,(in press). Aroclor fractions were introduced to Chlorella populations in 0.1% acetone. Treated populations were compared directly to control populations containing 0.1% acetone. Primary productivity was determined by measuring the uptake of carbon-14 using liquid scintillation counting (KRICHER et.al., in press). Data were expressed as $mgC/m^3/hr$. To compare effects of PCBs on different sized populations, productivity data are presented on a per cell basis.

Results and Discussion

Productivity measurements were made on Chlorella populations at 94 hours and 190 hours. Treated populations were exposed to Aroclor 1232 at 1 ppm and 100 ppb. Analyses of variance and subsequent calculation of least significant differences (STEEL and TORRIE, 1960) indicated significant differences ($p < .05$) between the treatment and control means with regard to per cell productivity. At both 94 and 190 hours, Aroclor treated cultures were significantly higher than controls (Table I). However, the per cell productivity decreased from 94 to 190 hours in the population exposed to 1 ppm Aroclor 1232 while it increased in the population exposed to 100 ppb (Table I). At 94 hours, control populations, which exhibited significantly lower per cell productivity than treated populations, showed distinctly greater population densities (Table I). An inverse relationship between population density and productivity has been well documented for Chlorella populations grown in limited volume (LEWIN, 1962; FOGG, 1965), and may have been operating in the present case. It is

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not possible to determine from the 94 hour data whether the higher productivity observed in the treated populations was due to Aroclor 1232 directly affecting carbon fixation or simply a response of "physiologically younger" Aroclor treated populations that were undergoing recovery from a PCB-induced initial depression in population growth. At 190 hours, when Chlorella populations no longer differed between control and treated with regard to density, the treated populations continued to exhibit significantly higher productivity (Table I). This result suggests that simple differences in density among populations may not be adequate to account for the productivity differences.

TABLE I

Density and Per Cell Productivity (Aroclor 1232).

Sample	Sample Pop. Density (cells/ml. x 10^6)	Per Cell Productivity ($mgC/m^3/hr/cells/ml.$)
94 Hours		
Control	5.33	195×10^{-6}
Acetone Control	5.52	197×10^{-6}
Aroclor 1 ppm	3.90	268×10^{-6}
Aroclor 100 ppb	4.94	208×10^{-6}
190 Hours		
Control	4.20	129×10^{-6}
Acetone Control	3.60	146×10^{-6}
Aroclor 1 ppm	4.14	231×10^{-6}
Aroclor 100 ppb	3.89	271×10^{-6}

Other experiments considered Aroclor fractions 1242, 1254, and 1268, all at concentrations of 1 ppm. Data were taken when cultures were 73 hours old. Analysis of variance and least significant differences indicated significance ($p < .05$) between the mean per cell productivity of both Aroclor 1242 and 1268, compared with control productivity. Aroclor 1254 was not significantly different than the controls (Table II). Results indicate that Aroclor 1242 appeared to enhance productivity while 1268 depressed it (Table II). This finding agrees with the theory that sublethal effects of PCBs have a direct correlation to chlorine content whereas lethal effects are inversely related (PEAKALL and LINCER, 1970). Since these measurements were made during ongoing population experiments (HAWES, et.al., in press) there were population density differences among treated cultures. The Aroclor 1242 cultures were 41% less dense than controls at 73 hours, while the 1254 cultures were 14% less dense, and the 1268 cultures 2% more dense (HAWES et.al., in press). The inverse linear correlation between population density and per cell productivity is evident in these Aroclor-treated cultures ($r = -0.980$). When control densities and per cell productivities are included with the treated cultures the correlation coefficient becomes $r = -0.753$ thus indicating that the relationship between density and productivity differs between treated and control cultures.

TABLE II

Density and Per Cell Productivity in Different Aroclor Fractions at 73 Hours.

	Sample Pop. Density (cells/ml. x 10^6)	Per Cell Productivity ($mgC/m^3/hr/cells/ml$)
Control (1)*	0.44	806×10^{-6}
Control (2)*	0.44	845×10^{-6}
Aroclor 1242	0.26	951×10^{-6}
Aroclor 1254	0.38	808×10^{-6}
Aroclor 1268	0.45	640×10^{-6}

*Controls contained 0.1% Acetone.

The results of these experiments indicate that the response of Chlorella populations to PCBs is not simple. Density, culture age, and Aroclor fraction are all factors which influence Chlorella's response.

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