Short communication

Influence of diethyldithiocarbamate on cadmium and copper toxicity to freshwater macrophyte *Spirodela polyrhiza*

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Abstract

Toxic effects of two heavy metals, cadmium (Cd) and copper (Cu), and a fungicide, diethyldithiocarbamate, have been evaluated, alone and in association, on *Spirodela polyrhiza* duckweed cultivated in a synthetic mineral medium and in a distilled water medium. The composition of the culture medium influenced the toxicity of the three compounds and the effects of their associations were clearly shown in the distilled water medium. Copper has an antagonistic effect on Cd and reduced its absorption by duckweed. On the other hand, Cd in the culture medium increased Cu absorption. The most significant effect was observed with diethyldithiocarbamate simultaneously associated with Cu and Cd. The diethyldithiocarbamate association largely inhibited the absorption of Cd and Cu by duckweed and so appeared to have a complexant effect that reduced the toxicity of these two metals.

Introduction

The natural environment is a particularly complex medium in which biological organisms can be exposed to various associations of chemical compounds (Babich and Stotzky, 1985; Friberg et al., 1976). Most ecotoxicological laboratory tests evaluate isolated chemicals, although it is known that interactions always occur in the environment when they are associated. On the other hand, one estimates that these interactions are often conducted to an enhancing toxicity (synergism) while not caring about reducting effects (antagonism). The aim of our study was to simulate interactive phenomena linked to the natural medium complexity and to evaluate the interactions between two heavy metals cadmium, (Cd) and copper (Cd), and a fungicide, diethyldithiocarbamate (DDTC). The choice of these three chemicals was based on the fact that Cd and Cu are common and worrying environmental pollutants while diethyldithiocarbamate is a fungicide, but is also a well-known complexing compound used as an antidote for human detoxification treatment (Grafsträn and Greene, 1980).

For this work, we used a strain of duckweed *Spirodela polyrhiza* maintained on a synthetic culture medium. Previous studies have shown the interest of this test species for the evaluation of toxic phenomena involving heavy metals, especially Cd (Charpentier et al., 1987). Duckweed is easy to cultivate in a laboratory. Its short duration vital cycle and the homogeneity of its populations are favorable factors for their use in ecotoxicological evaluations and constitute a species of choice for the study of the toxic impact of chemicals on freshwater ecosystems (Charpentier and Garnier, 1985).

Cd, Cu and DDTC were first studied separately by determining the influence of the composition of duckweed culture medium. Different assays were performed in parallel studies with a synthetic mineral medium and with a distilled water medium.

In a second step, we compared the effects of different possible associations between Cd, Cu and DDTC on the metal biosorption of duckweed *Spirodela polyrhiza* which was cultivated in a distilled water medium.

TABLE 1
Composition of the Homes modified culture medium

NaH_2PO_4, 2 H_2O	0.6 x 10^{-3} mol/ℓ
KNO_3	2.3 x 10^{-3} mol/ℓ
$MgSO_4$, $7H_2O$	0.5 x 10^{-3} mol/ℓ
$Ca(NO_3)_2$, $4H_2O$	0.7 x 10^{-3} mol/ℓ
EDTA	16.0 x 10^{-6} mol/ℓ
H_3BO_3	1.6 x 10^{-6} mol/ℓ
$MnSO_4$	8.0 x 10^{-6} mol/ℓ
$CuSO_4$	1.0 x 10^{-6} mol/ℓ
$(NH_4)_6Mo_7O_{24}$, $4H_2O$	0.94 x 10^{-8} mol/ℓ
pH	5.4 $\pm$ 0.2

Material and methods

Spirodela polyrhiza L., strain S.C. 83, was harvested in 1983 in a freshwater pond in Normandy and then acclimatised and maintained in our laboratory. The strain was maintained in an exponential growth phase in a synthetic culture medium (Thellier, 1963) which is a modified Homes culture medium (Table 1). Culture bottles were placed in a 24$\pm$1°C thermostated room under a 1600 lux continuous white light. Every 8 d, which is the maximum delay for macrophyte population doubling, fronds were transferred to the fresh culture medium.

Study of Cd, Cu and DDTC alone

Concentrated toxic solutions were prepared in freshly distilled water with cadmium chloride ($CdCl_2$), copper sulphate ($CuSO_4$,$5H_2O$) and sodium diethyldithiocarbamate (DDTC-Na). These concentrated solutions were diluted in distilled water or in a mineral medium to obtain a concentration range (Cd 0, 0.05, 0.1,

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Received 19 June 2000; accepted in revised form 5 October 2001.