PHYTOTOXICITY OF HALOACETIC ACIDS AND OF SOME DERIVATIVES.

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Most haloacetic acids have high mammalian and invertebrate toxicity; fluoroacetate for instance is widely employed as rodenticide, has been suggested as insecticide, and has caused losses in live-stock in areas where fluoroacetate-containing plants are abundant (South Africa, Australia).

Monochloroacetate (MCA) and trichloroacetate (TCA) or derivatives thereof are well-known herbicides (e.g. alachlor, propachlor), and monohaloacetates are amongst the most potent algal toxicants. Haloacetic acids occur also in ambient air, in precipitation, and in conifer needles from non-polluted regions; therefore, their involvement in the so-called forest decline symptoms and in other ecotoxicological phenomena need be studied in more detail. Such investigations are timely, since environmental burden of some haloacetic acids may be expected to increase when partially halogenated C_2-chlorofluorocarbons (HCFC's) are becoming more widely employed as CFC-substitutes.

The uptake, metabolism and toxicity of MCA, TCA and several derivatives thereof have been studied with suspension cell cultures of bean, potato and spruce. MCA (figure 1) and TCA reach much higher cytosolic concentrations in spruce cells than extracellular concentrations. This suggests that haloacetic acids are taken up by active transport.

The rates of metabolism of both acids differ greatly; while trichloroacetate is only slowly metabolized ($<0.07\ d^{-1}$), the metabolic rate constant for monochloroacetate is in the range of about $0.2\ d^{-1}$. This complies with the fact that steady-state concentrations of MCA in conifer needles from non-polluted forests are lower than those of TCA, while the reverse is true for representative levels in rural air and rain.

The acute phytotoxicities of TCA, MCA and of some derivatives have been determined monitoring growth curves of bean cell suspension cultures. The EC_{50}-values (concentration at which growth is inhibited by 50 %) are listed in table 1. Obviously, non-ionic derivatives of TCA are considerably more toxic than the free acid, probably due to more facile permeation of plasmalemma and organelle membranes. Comparison of these results with literature data suggest that large species differences in phytotoxicity are typical for haloacetates.

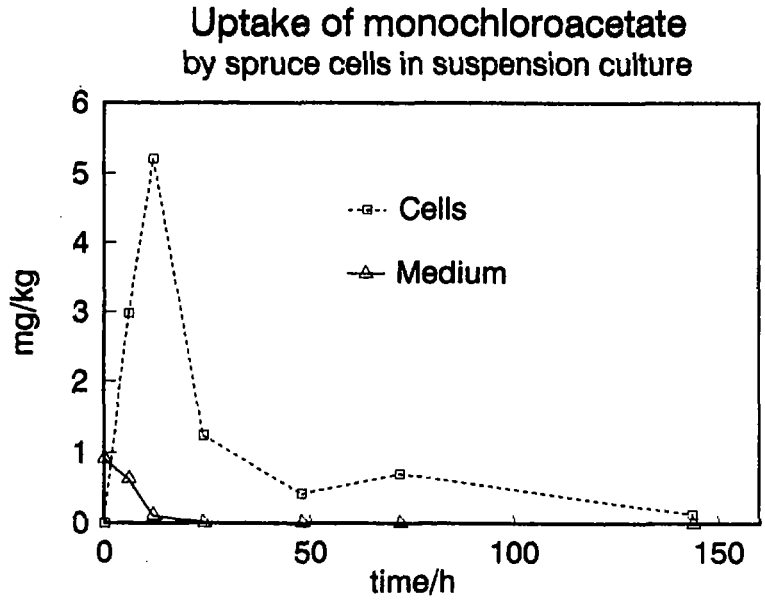

Table 1: Phytotoxicity of chloroacetates, non-ionic derivatives, and selected phytotoxicants; (a) EC_{50} and (b) EC_{10} (toxicity threshold) [µmol/L] of cellular growth of bean cell suspension, growth period 2 weeks; (c) toxicity threshold EC_{10} [µmol/L] in the multiplication inhibition test with *Scenedesmus suspicatus* or *Scenedesmus quadricauda*; (d) typical maximum concentrations in pine needles [µmol/kg fresh weight], concentrations calculated on the basis of aqueous needle tissue compartment are shown in parentheses.

compound	a	b	c	d
Trichloroethanol	3000	220	-	
Chloral	3600	160	17	
Trichloroacetate	600	200	1000	0.8 (1.6)
Pentyl trichloroacetate	140	56	-	
Trichloroacetyl amide	180	2	-	
Methyl trichloroacetate	60	4	-	
Tetrachlorooxirane	60	6	-	
Dichloroacetate	1200	400	-	
Monochloroacetate	200	60	0.07	0.2 (0.4)
Alachlor	120	14	-	
Monofluoroacetate	-	-	0.7	