EFFECTS OF CADMIUM ON GROWTH AND PHARMACOLOGICALLY ACTIVE CONSTITUENTS OF THE MEDICINAL PLANT CORIANDRUM SATIVUM L.

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Abstract. The effects of high levels of cadmium in soil and in the atmosphere on the plants of Coriandrum sativum L. (Umbellifereae) were investigated. Plants grown in contaminated soil (0, 10, 100 ppm of cadmium) showed a significant reduction in the length of the stems and roots and the number of the umbels, a yellowing and ultrastructural alterations of the leaves and a significant decrease in the essential oil composition. Similar effects were observed in the plants exposed to a simulated atmospheric pollution (plants were sprayed with CdCl₂ solutions containing Cd 0, 10, 100 mg/L). The effects are related to a degree of environmental contamination.

1. Introduction

Cadmium is an important environmental pollutant which is supplied to the soil mainly by commercial fertilizers, precipitation, and also by sewage sludge, manure and lime (Andersson, 1977; Pacyna, 1984; Nriagu and Pacyna, 1988). Many studies, carried out in the context of environmental pollution, showed that high levels of cadmium produces chlorosis and necrosis (Chaney et al., 1978; Cox, 1986), a decrease in productivity (Miles and Parker, 1979) and altered enzymatic activity (Van Assche et al., 1984; Miles and Parker, 1980; Lakshaman et al., 1992). Several authors reported that many effects of cadmium in the plants could be also explained by nutrient deficiency (Khan and Khan, 1983). Cadmium, in fact, influences uptake and utilization of mineral nutrients (Greger and Lindberg, 1986) and interferes with various biochemical mechanisms and functions (Howden and Cobbett, 1992). However little is yet known about the qualitative and quantitative modification of the secondary metabolites which are the pharmacologically active constituents of medicinal plants (De Pasquale et al., 1988a; De Pasquale et al., 1988b; De Pasquale et al., 1989; Galati et al., 1989).

Coriandrum sativum L. (Fam. Umbellifereae) is an umbelliferous, aromatic, annual, herbaceous plant. Although the leaf as well as the fruit is used as flavouring, the latter is by far the more common. The distilled oil has a characteristic aromatic odour and a sweet spicy taste, and may constitute as much as 1% of the fruit. It is used in the food industries, pharmaceutics, and perfumery. In the form of an infusion, coriander is useful as a carminative and in the treatment of intestinal
disorders. It also has antispasmodic and expectorant properties; externally, it is used in ointment for the treatment of rheumatism and arthritis (Ceska et al., 1988).

The main volatile compounds of coriander oil are linalool (about 60–70%), α- and β-pinene, terpinenes, geraniol, camphor and geranyl acetate (Lawrence et al., 1984).

In the present work we studied the effects of high levels of cadmium in soil and in the atmosphere on the growth, morphological features, and essential oil composition of Coriandrum sativum L.

2. Material and Methods

Plant material was grown in a greenhouse from seeds kindly supplied by The Botanic Garden of Padova and identified as Coriandrum sativum L.

Soil (containing 0.08 ppm of cadmium) was collected in our experimental garden, sieved, dried and filled into standard pots (30 cm diameter) containing equal weights of soil (7 kg/pot).

2.1. Soil Cadmium

To simulate soil pollution, the soil was amended with CdCl₂ solution to produce cadmium addition levels of 0, 10 or 100 ppm. The soil was watered to field capacity and incubated in the greenhouse for ten days to allow the soil chemical reactions to equilibrate before seeding (Miles and Parker, 1979). Ten seeds were planted in each pot and there were ten pots for each dose of cadmium. Germination was recorded every three days.

2.2. Foliar Cadmium Application

The seeds were planted in ten neighbouring pots. When the plants reached a height of about 20 cm, they were sprayed with CdCl₂ solution containing Cd 0, 10 or 100 mg/L, to simulate atmospheric pollution. Equal volume of Cd solution was sprayed (100 mL/pots) twice a week, for five months, until harvest.

Seven months after seeding, when the fruit ripened, the plants were harvested and analyzed.

2.3. Cadmium Content

The harvested plant material was repeatedly and carefully washed with distilled water to remove surface contamination, air dried, and wet ashed: 1 g of powdered sample was digested overnight in 10 mL 50% HNO₃, filtered, brought to a volume with distilled H₂O (Kahn et al., 1972) and then 1 mL 10% NH₄H₂PO₄, as matrix modifier, was added (Slavin et al., 1983). Cadmium was measured by an atomic