Annals of the University of Craiova
The Chemistry Series
Volume XLIX, No. 2 (2023) 45-48
homepage: chimie.ucv.ro/annals/
10.52846/AUCCHEM.2023.2.11

Erythromycin decreases photosynthetic pigments content in plants from the *Brassicaceae* family

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Received: 19.08.2023 / Accepted: 20.08.2023 / Published: 20.12.2023

Abstract:
Young *Brassicaceae* plants grown on solidified nutrient solutions were exposed to erythromycin in their growth media at concentrations ranging from 10 to 40 $\mu mol \cdot L^{-1}$. At 7 days from the onset of the experiment, the plants were harvested, their growth parameters were evaluated, and the leaves were assayed for chlorophyll and carotenoids contents. The obtained results pointed out a dose dependent decrease of both chlorophyll and carotenoids contents in plants' leaves. The plants exposed to erythromycin also had shorter stems and roots compared to control plants. A negative effect of erythromycin on photosynthesis, by inhibiting chloroplast protein biosynthesis, chloroplast assembly and function is discussed.

Keywords: *Brassicaceae* plants, erythromycin, photosynthetic pigments, protein synthesis, chloroplast biogenesis and function

1. INTRODUCTION

The main structural feature of antibiotics in the macrolide class, of which erythromycin was the first one discovered, is the presence of a lactone macrocycle to which one or more deoxy-sugar or amino sugar residues are attached [1]. Macrolide antibiotics act by binding to the bacterial ribosomes and inhibiting protein synthesis [2].

Erythromycin has a wide range of uses, a slow rate of biodegradation, a very stable chemical structure and the ability to cross biological membranes. The concern regarding the effects of erythromycin in plants is mainly for cultivated ones, whose exposure is favored by antibiotic contamination of water and soils, due to incorrect management of specific residues [3, 4].

2. MATERIALS AND METHODS

2.1. Biological material and experimental conditions

Seeds of two edible plants from *Brassicaceae* family that are eaten raw, namely garden cress (*Lepidum sativum*) and rocket (*Eruca sativa*), were purchased from the local stores. Prior to sowing, the seeds were surface sterilized by immersion for 5 min in a 5% NaClO solution, then they were washed repeatedly with distilled water. In order to germinate and grow, the seeds were planted in Petri dishes of 90 mm in diameter, filled with Hoagland solution supplemented with erythromycin. Pharmaceutical grade erythromycin powder was used to prepare a stock solution of 1 $mmol \cdot L^{-1}$, from which dilutions were made, in order to obtain concentrations of erythromycin of 10, 20 and 40 $\mu mol \cdot L^{-1}$, respectively. The Petri dishes were kept at room temperature, under natural lighting conditions (photoperiod of 16/8 hours), and temperature of 25/20 °C. At 7 days from the onset of the experiment, plant leaf samples were collected for the extraction and assay of the photosynthetic pigments.

2.1. Sample preparation and biochemical assays

For *chlorophylls* (c_a, c_b) *and carotenoids* ($c_{(x+c)}$) extraction, samples of 0.03 g of fresh leaf tissue were ground using 3 mL of 100% acetone. The extracts were centrifuged for 10 min at 8000 rpm and 4 °C, and their absorption spectra in the visible domain were recorded with a Varian Cary 50 spectrophotometer. Calculation of the pigments' concentration, as $\mu g \cdot mL^{-1}$ in the acetone extract, was performed using the equations of Lichtenthaler [5], and reported to the sample's fresh weight (FW). The presented results are the mean values ± standard deviations of the assayed parameters. The calculation and graphs were done with the Microsoft Excel software, the 2013 version.

3. RESULTS AND DISCUSSION

In the leaves of the plants grown in this experiment, chlorophylls and carotenoids concentrations markedly decreased after the exposure to erythromycin (figures 1 and 2).

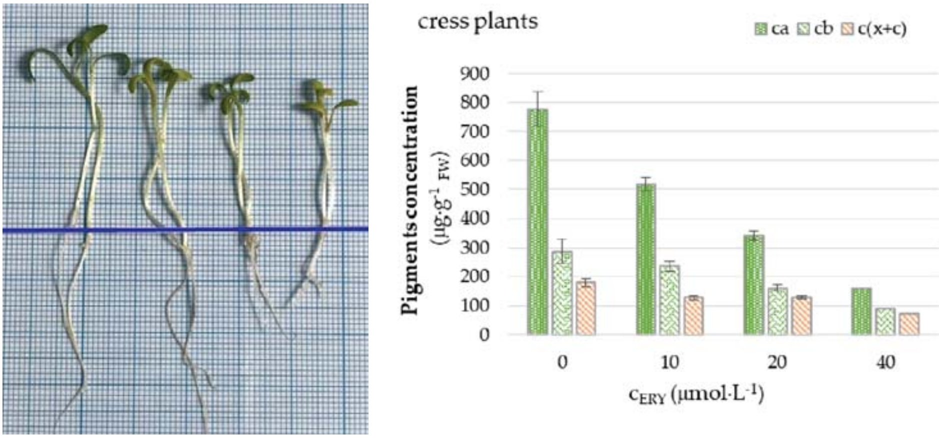

Figure 1. Effects of the exposure of cress plants to erythromicin: growth inhibition of cress plants (*left*), and their leaf pigments concentration (*right*).

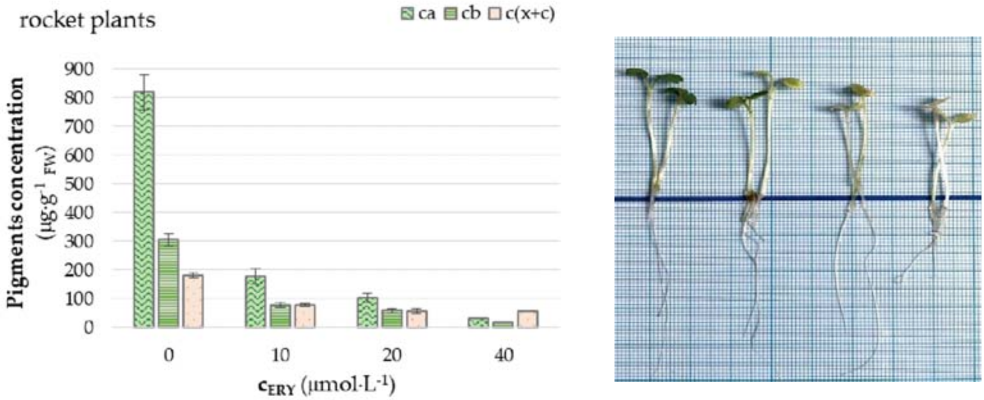

Figure 2. Effects of the exposure of cress plants to erythromicin: leaf pigments concentration of the rocket plants (*left*) and their growth inhibition (r*ight*).

The plants exposed to erythromycin had shorter stem and root than the unexposed ones, growth inhibition being also dose-dependent.

4. CONCLUSION

Following the exposure to erythromycin, a dose dependent growth inhibition, paralleled by a decreased leaf pigment concentration was observed in both plant series; rocket plants appeared to be more sensitive than cress ones. As chloroplasts (and mitochondria, too) have their own, prokaryotic-type ribosomes that synthesize specific proteins, the observed effects may be related to an impairment of the synthesis of these proteins that was caused by erythromycin.

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