

Changes of antioxidants following powdery mildew infection of near-isogenic barley lines carrying different resistance genes

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ABSTRACT Activities of several antioxidative enzymes (SOD, APX, GST and POX) were enhanced in barley leaves following powdery mildew infection, most significantly in case of the susceptible cultivar. In three different powdery mildew resistant lines (carrying *Mla*, *Mlg* or *mlo* resistance genes) we detected similar changes, but less pronounced as compared to the susceptible variety. CAT activity did not change significantly. DHAR activity decreased in all powdery mildew infected barley lines. Ascorbate and glutathione levels increased in the susceptible variety.
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KEY WORDS

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In order to better understand the role of antioxidants in the barley–powdery mildew interaction we have measured the activities of several important antioxidative enzymes and the amount of non-enzymatic antioxidants ascorbate and glutathione in powdery mildew inoculated barley leaves with various forms of resistance. Király and colleagues (1995) have already shown that antioxidant changes might be important in the susceptible or resistant reaction to pathogen infection. Our studies comprised further antioxidant enzymes and barley lines with several different resistance forms.

Materials and Methods

Barley (*Hordeum vulgare* L. cv. Ingrid) lines without or with *Mla*, *Mlg* or *mlo* resistance genes were grown in greenhouse. Leaves of 7-day-old seedlings were inoculated with powdery mildew (*Blumeria graminis* f. sp. *hordei*) race A6. First (lowest) leaves were used for antioxidant assays.

The extraction and determination of enzyme activities of catalase (CAT), ascorbate peroxidase (APX), glutathione-S-transferase (GST), guaiacol peroxidase (POX), dehydroascorbate reductase (DHAR), were carried out as described earlier (Fodor et al. 1997; Király et al. 2002). Superoxide dismutase activity was assayed by the method of Paoletti and Mocali (1990). Ascorbate content was determined by the bipyridyl method of Okamura (1980) modified by Knörzer et al. (1996). Glutathione was determined by the enzymatic method of Law et al. (1983).

Results and Discussion

We have detected an increased activity of many antioxidative enzymes (SOD, APX, GST and POX) following powdery mildew infection, especially explicit 7 days after inoculation

(Table 1). POX activity showed the earliest induction after inoculation. CAT activity did not change considerably at any time point after inoculation in any case. On the other hand, DHAR activity notably decreased after 7 days as compared to the non-inoculated control. Antioxidant levels significantly increased only in the susceptible cultivar 7 days after inoculation, glutathione content was 2-fold and ascorbate content was 3-fold higher than in the control. In the case of ascorbate the ratio of the reduced and oxidised forms had increased as well.

We can conclude that powdery mildew inoculation resulted in antioxidant changes in the different barley lines, but in each case the susceptible cultivar showed the highest differences compared to its own, non-inoculated control. Similar changes in enzyme activities were observed in the resistant lines, but always to a lesser extent than in the susceptible variety. Our results suggest that antioxidants seem to be induced in the susceptible relationship to protect the pathogen from the detrimental effects of reactive oxygen species produced during the defence reaction of the plant.

Table 1. Activities of superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione-S-transferase (GST), guaiacol peroxidase (POX) and dehydroascorbate reductase (DHAR) enzymes in barley leaves 7 days after powdery mildew inoculation. Values are indicated as a percentage of the non-inoculated control in case of each of the susceptible (Ingrid) and resistant (*Mla*, *Mlg*, *mlo*) lines (control = 100%).

	Ingrid	Mla	Mlg	mlo
SOD	531%	283%	207%	235%
APX	261%	145%	114%	114%
GST	324%	175%	106%	110%
POX	512%	285%	181%	131%
DHAR	51%	58%	96%	80%

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