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Response of Peroxidase and Amylase Isoenzyme Activities of *Aesculus hippocastanum* and *Picea abies* to Gamma and Beta Irradiation (Short Communication)

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Summary

LICKL E., BECK R. H. F. & EBERMANN R. 1987. Response of peroxidase and amylase isoenzyme activities of *Aesculus hippocastanum* and *Picea abies* to gamma and beta irradiation. – Phyton (Austria) 27 (2): 177–180. – English with German summary.

Gamma and beta irradiation (10 Gy, 30 Gy) of wood and leaves of *Aesculus hippocastanum* and of wood of *Picea abies* does not influence the activity of peroxidase isoenzymes (E.C.1.11.1.7.); amylase (E.C.3.2.1.) activity however is affected.

Zusammenfassung

LICKL E., BECK R. H. F. & EBERMANN R. 1987. Aktivitätsänderungen von Peroxidase- und Amylase-Isoenzyme von *Aesculus hippocastanum* und *Picea abies* durch Gamma- und Beta-Strahlen. – Phyton (Austria) 27 (2): 177–180. – Englisch mit deutscher Zusammenfassung.

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Bestrahlung von Holz und Blättern von *Aesculus hippocastanum* und *Picea abies* läßt die Aktivität der Peroxidase-Isoenzyme (E.C.1.11.1.7.) unbeeinflußt, die Aktivität der Amylase (E.C.3.2.1.) indessen wird verändert.

Introduction

The supply of energy by means of cosmic irradiation is about 1×10^{-3} till 1×10^{-1} Gy each year (BOCK & ELSTNER 1984). Higher amounts of irradiation alter the genetic disposition (BORS & al. 1979, ANONYMUS 1977). In meristematic tissues the enzyme activities are mainly decreased (KUROBANE et al. 1979; ROY & SAMBORSKY 1982, INOUE & al. 1980) or the isoenzyme patterns changed by mutation (KELLY & LINEBERGER 1981, ENDO 1967). It is referred that in herbaceous plants the sucrose metabolism is enhanced (HAYASHI & al. 1984), the polyphenoloxidase isoenzyme profiles however are not affected (THOMAS & DELINCEE 1981).

To our knowledge there has been no experimental evidence on activity staining of peroxidase and amylase isoenzymes in leaf tissue and wood after exposure to rays so far. In this work the effect of irradiation is demonstrated immediately after radiation treatment. Metabolic processes either spontaneously or as response to irradiation are excluded therefore.

Experimental

Unwounded leaves of horse-chestnut *(Aesculus hippocastanum* L.) and branches with a diameter of ca 0.5 cm of horse-chestnut and spruce (*Picea abies* [L.] KARST.) were collected in June. The branches were milled with a pencil-sharpener.

1.00 g of plant material (entire leaves and fresh shavings of branches) were exposed to rays with 10 Gy (= 1000 R) and 30 Gy (= 3000 R) at a dose rate of 74 R/min by ^{60}Co and of rapid electrons at 45 MeV.

Directly after irradiation the leaves were ground with a mortar and pestle. Leaf tissue and wood shavings were extracted overnight at + 4° C (1.00 g in 4 ml buffer) according to EBERMANN & STICH 1982. Gel electrophoresis in polyacrylamide (EBERMANN & STICH 1982), detection of peroxidase with o-dianisidine and H_2O_2 (GABRIEL 1971) and amylase isoenzymes (EBERMANN & STICH 1982) were performed as described earlier.

The classification of the staining intensity was done by visuel comparison of the patterns.

Results

In Table 1 the data yielded by PAGE are presented. In not a single case the pattern of the isoenzymes of peroxidase (E.C.1.11.1.7.) or amylase (E.C.3.2.1.) is changed by irradiation treatment. The peroxidase isoenzymes of horse-chestnut *(Aesculus hippocastanum)* and spruce *(Picea abies)* are unaffected by either gamma (^{60}Co) or beta (rapid electrons) irradiation with

10 and 30 Gy. On the other hand the intensity of the activity staining of amylase is increased or decreased in certain cases unequivocally. Leaf and wood of horse-chestnut are however differently sensitive when exposed to equal rates.

With beta irradiation only the activity of amylase of leaf is increased with 10 Gy irradiation, whereas the amylase of wood is decreased with the same dose. 30 Gy decreases the activity of both leaf and wood of horse-chestnut, and of wood of spruce in any case.

Gamma irradiation with 10 Gy of wood (horse-chestnut and spruce) increases the activity, with 30 Gy all enzyme activities are weakened. The leaf of horse-chestnut shows no change in activity with 10 Gy gamma irradiation, but with 30 Gy a diminuation of the activity of amylases.

Table 1

Activity of peroxidase and amylase isoenzymes of plant tissue of *Aesculus hippocastanum* and *Picea abies* after irradiation compared with untreated samples.
0 = no difference of activity compared with untreated samples.
+ = increase of activity compared with untreated samples (at least doubled).
– = decrease of activity compared with untreated samples (at least halved).

Mode of irradiation		gamma		beta	
Dose (Gy)		10	30	10	30
Peroxidase					
A. hippocastanum	leaf	0	0	0	0
	wood	0	0	0	0
P. abies	wood	0	0	0	0
Amylase					
A. hippocastanum	leaf	0	–	+	–
	wood	+	–	–	–
P. abies	wood	+	–	–	–

Discussion

Peroxidases have been used as markers for studying numerous physiological processes as well as for testing the effect of several chemical substances on plant cells. Peroxidases usually respond to changes in environmental conditions, that are infection agents and injuries (CASTILLO 1985). Therefore peroxidases are useful as markers of stress. Nevertheless neither gamma nor beta irradiation at the dose used influences the activity of peroxidase isoenzymes of wood and leaf tested.

Mutagenic alterations of the isoenzyme patterns are excluded so far, as the effect of irradiation is demonstrated immediately after radiation treatment. No change in the isoenzyme pattern was noticed at all.

The disposability of reserve polysaccharides is most important to the energy management of plants. The energy accumulated by reserve polysaccharides is available after the degradation of the polysaccharides by hydrolysing enzymes. The amount of disposable energy of plants accumulating starch results from the activity of the amylases, if the energy produced by the photosynthesising system is neglected. Increased activities of amylases yield more glucose and malto-oligo-saccharides, that could be used for an increased metabolic process, but also an increased degradation and consumption of the reserve polysaccharides. The alteration of the amylase enzyme activity by gamma and beta irradiation seems therefore to be an encroachment on metabolic pathways.

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